19 MAY 1961

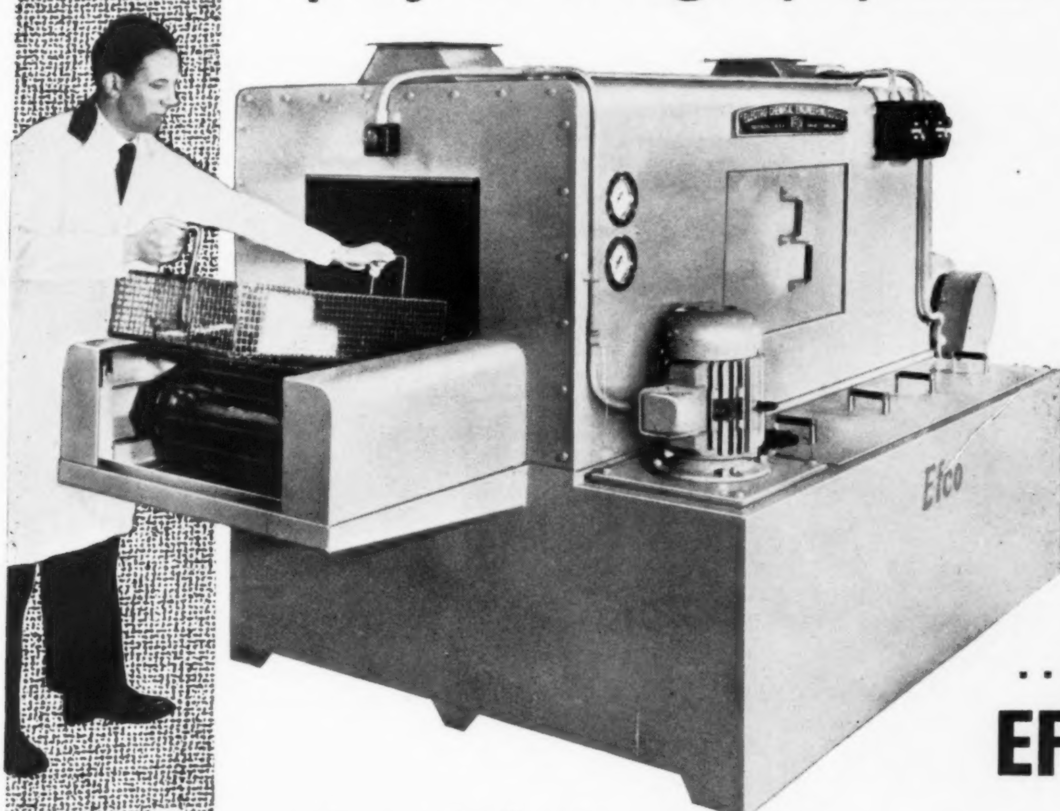
METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS

VOL 98 No 20

ONE SHILLING

a new range of standard spray washing equipment . . .



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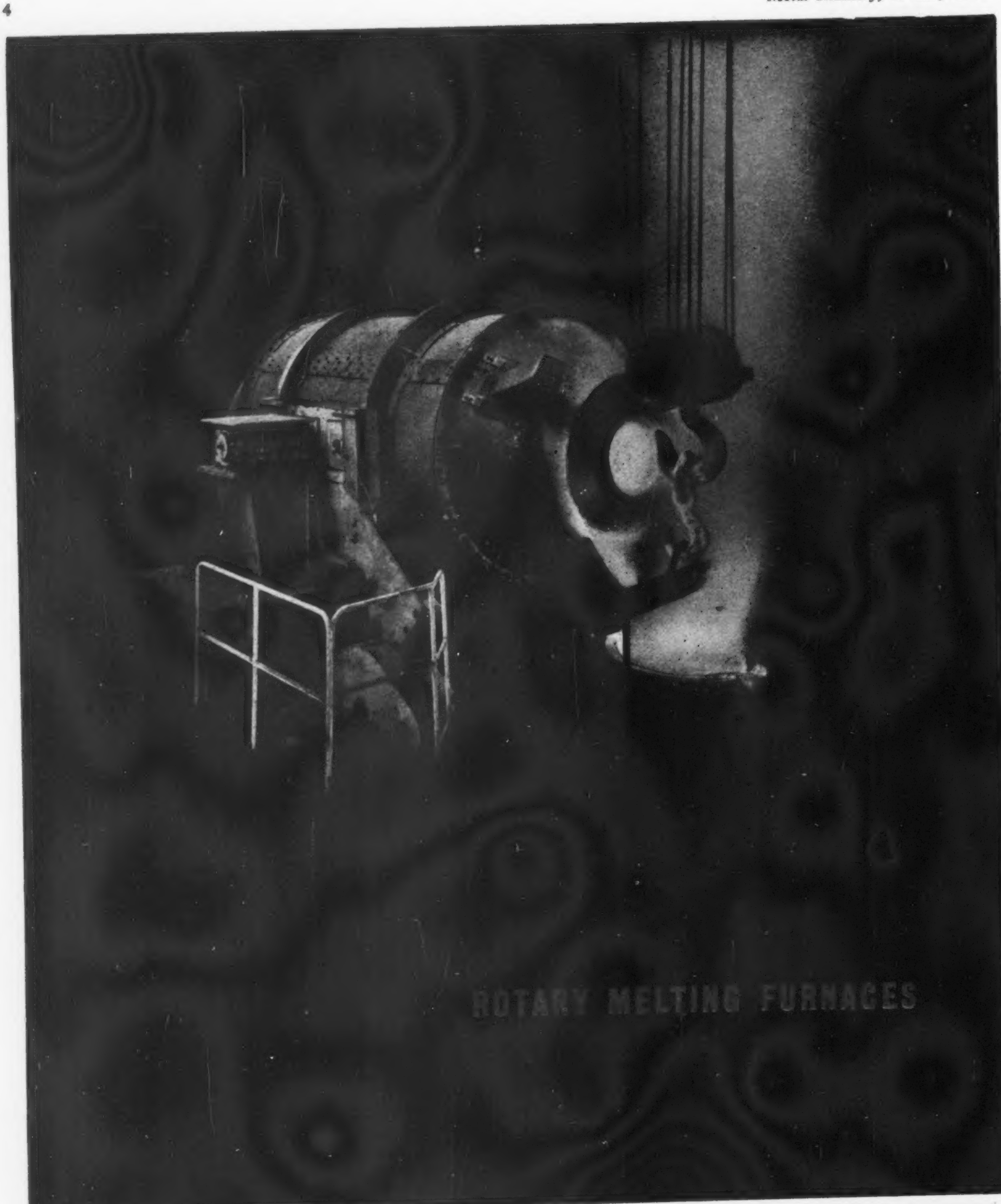
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(photographs by courtesy of Hunt & Mitton Ltd.)

Illustration shows a 6" bore Globe Stop Valve for 275 p.s.i. Liquid Oxygen minus 130°F.

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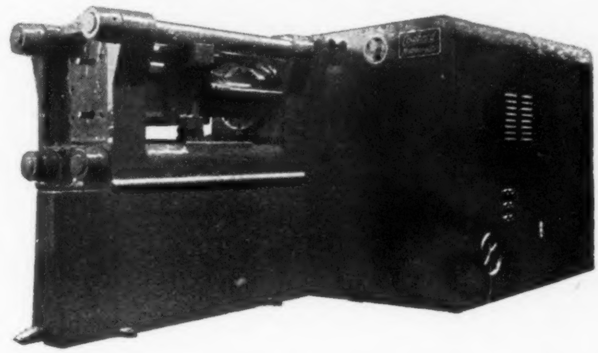
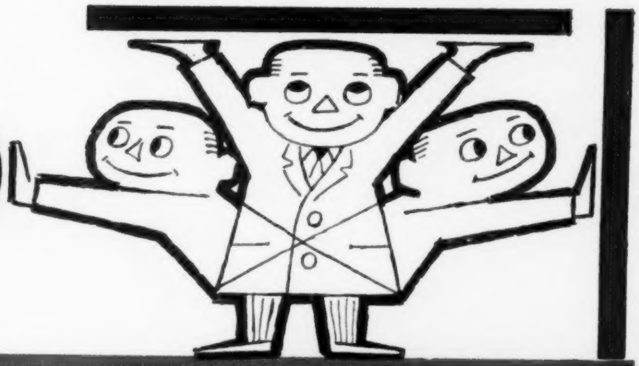
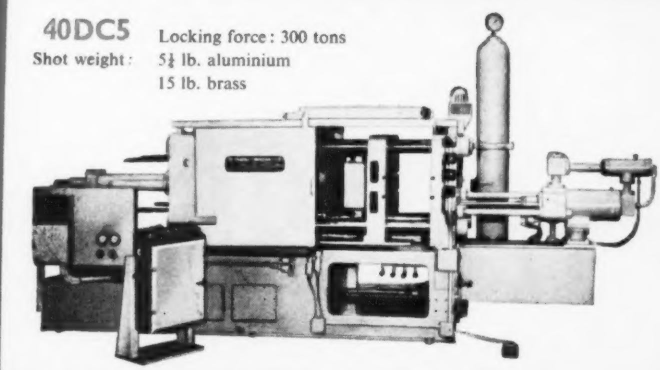
P.5813



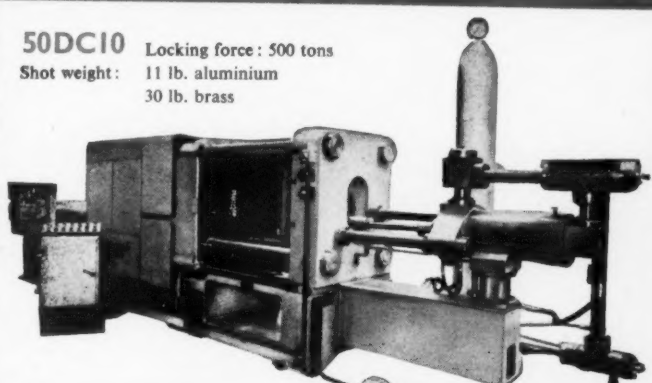
PECO TRIO



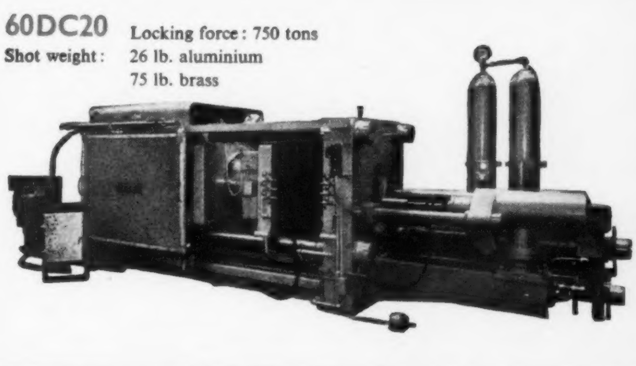
40DC5 Shot weight: Locking force: 300 tons
5½ lb. aluminium
15 lb. brass



50DC10 Shot weight: Locking force: 500 tons
11 lb. aluminium
30 lb. brass



60DC20 Shot weight: Locking force: 750 tons
26 lb. aluminium
75 lb. brass



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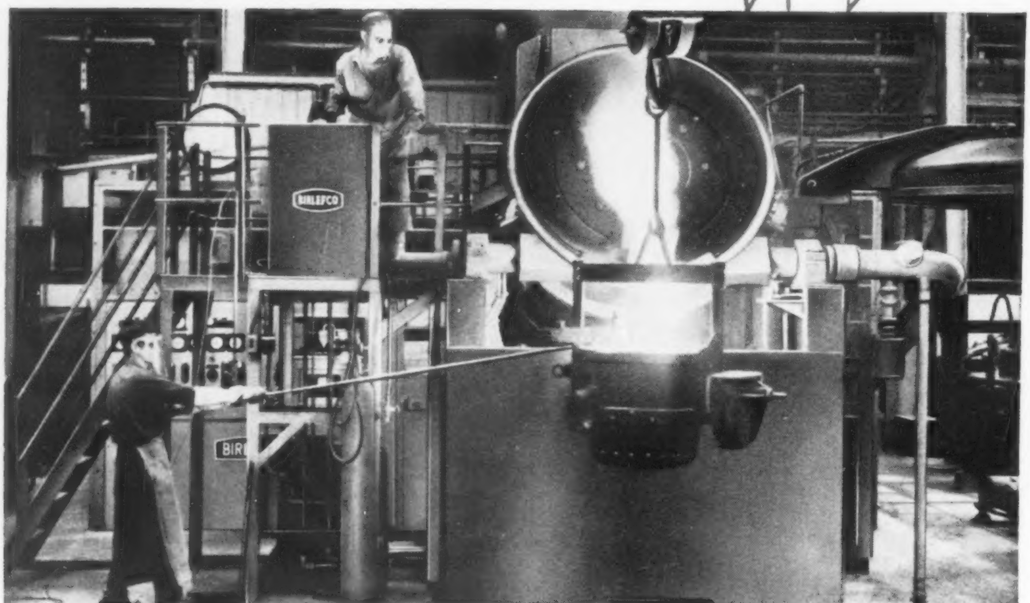
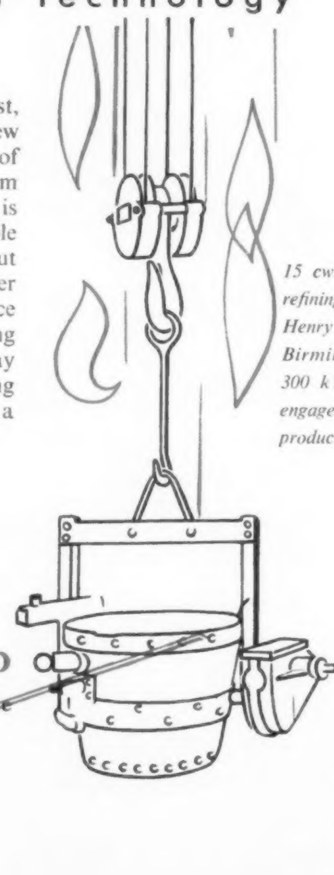


Birlefco advance in vacuum technology

At a considerably reduced capital and operating cost, compared with conventional vacuum melting, the new Birlefco de-gassing and refining furnace ensures metal of high purity and uniform properties. Molten metal from an auxiliary source is charged into the furnace, which is a mains frequency induction unit housed in a tiltable vacuum tank. Chamber pressure is then reduced to about 250 microns and less within a quarter of an hour. After vacuum treatment air is re-admitted into the furnace chamber and the metal is poured into a ladle for casting or teeming in the conventional manner. In this way practically all the benefits of induction vacuum melting can be obtained on a continuous production basis at a cost of only a few pence per lb. of metal treated.



15 cwt. Birlefco vacuum refining unit installed at Henry Wiggin & Co. Ltd., Birmingham. Rated at 300 kW, the furnace is engaged on special alloy production.

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④

METAL INDUSTRY

FOUNDED 1909

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METAL INDUSTRY

VOLUME 98 NUMBER 20 19 MAY 1961

Progress Report

COMPLETION of fifteen of the sixty researches "in progress" or "due to be started" in 1960 is announced by the British Non-Ferrous Metals Research Association in its Annual Report. This reflects the present procedure which requires that when specific objectives are attained any research will be closed down, and, if agreed by the guiding committee, a new investigation put in hand on a selected phase of the work. Six more of the researches listed last year are approaching completion and are expected to be rounded off during the first half of 1961; two or three others have been put in abeyance. Of the fourteen "new researches" initiated last year, good progress has been made in about half, while the other half had only just started by the end of the year because of shortage of staff.

Some indication of the variety of researches undertaken can be gained from the headings in the Annual Report, which include such items as analytical methods, instrumentation, melting and casting, welding and fabrication, mechanical properties, corrosion, oxidation and protection, protective coatings, and electroplating. Thus the possibility of replacing pressure testing of copper housing tubes by eddy-current inspection is being examined, the instrument being capable of rejecting faulty tubes on one side and accepting good tubes into another pile. A roller-contact thermocouple for measuring the temperature of extrusions close to the die is also now under construction for industrial trials.

A new research was started during 1960 to determine the causes of hard spots in cast and extruded brasses and to find methods of preventing their formation. The initial work consists of a study of the solubility of iron-rich phases in simple and complex alloys, with particular reference to the influence of impurities such as silicon and boron. While the results should prove of interest to brassfounders generally, the greatest need for this research is in the prevention of hard spots in extrusions, which damage the die and create difficulties in automatic processes which include machining or hot stamping. Several researches are concerned with the manufacture and properties of high conductivity copper wire. A laboratory apparatus has been developed which placed a number of lubricants and die materials in the same order as regards die wear as practical experience of the selected materials when used for drawing copper. If this promising result is substantiated, the test will be used to determine the reasons for the increase in die wear that occurs when the lubricant ages, and may in the future be used to assess a wider range of alternative die materials.

Foundry characteristics of the hyper-eutectic aluminium-silicon alloys have also been the subject of intensive study. These materials need special refining techniques in order to attain the correct particle size of the primary silicon so as to avoid unsoundness. The alloys have a low coefficient of expansion, and, because of the high silicon content (18 per cent), good wear resistance. They can readily be pressure die-cast to close tolerances and used in engine blocks their lightness should result in a better weight distribution in motor cars. Wear tests are in progress on a range of these alloys, as also are measurements of the long-term dimensional stability of the materials at engine operating temperatures.

Appreciation of the value of the work done by the B.N.F.M.R.A. is not by any means confined to British industry. It is, for instance, gratifying to note that during 1960 research contracts were placed by such overseas organizations as the Copper Products Development Association of New York, the Cobalt Development Association of Brussels and the American Zinc Institute.

Out of the
MELTING POT

Unyielding Strength

BOTH the causes of the strength of solids being so much lower than the theoretical, and the circumstances in which the strength may approach the theoretical are well known. Among the former are the various structural faults, dislocations and the like, as well as surface cracks and imperfections which may either be already present in the material or which may develop during the very first stages of plastic deformation. Circumstances in which the theoretical strength of a solid is approached include those found in the so-called "whisker" forms, which are substantially free from dislocations and in which the whole of the deformation undergone up to fracture is elastic. Where surface cracks and imperfections play the predominant part in reducing the strength of a solid, a marked increase in strength can be achieved in circumstances in which such imperfections, both existing and those newly formed, are removed, as, for example, in the classic experiments in which crystals of rock salt were tested under water, dissolution of the surface layers of the crystals ensuring removal of weakening defects. A marked increase in the strength of macroscopic single crystals can also be obtained by testing them in circumstances in which plastic deformation (by slip and twinning) cannot occur. Such circumstances are more readily achieved in the case of crystals having a hexagonal structure which, at lower temperatures, have only a limited number of planes in which slip and twinning can occur. Working on this principle, single crystals of beryllium having a purity of 99·9 per cent and a prismatic shape ($1{\cdot}6 \times 1{\cdot}5 \times 3$ mm.) were tested in compression at 77°K. at a straining rate of 0·013 per cent/sec., the orientation of the specimens being such that the basis plane was perpendicular to the direction of compression. In these circumstances, the possibility of both slip and mechanical twinning was excluded, and the crystals were found to exhibit a high strength, failure occurring instantaneously at a compressive stress of 410 kg/mm^2, the specimen shattering into a very fine powder. At room temperature the ultimate strength of similarly oriented specimens was reduced to 210 kg/mm^2, because of the occurrence of limited slip on the pyramidal plane. The above ultimate stresses compare with an ultimate stress of only 34 kg/mm^2 at 77°K. exhibited by specimens oriented in a manner permitting slip to take place. A similar marked increase in ultimate strength was exhibited by suitably oriented single-crystal specimens of calcite, which on fracture also crumbled to a fine dust.

Heating Bed

SOME of the disadvantages and limitations of electrical resistance heating using one or other of the known types of heating elements are avoided in a method in which the resistance element is formed by a fluidized bed of particles of a conductive solid through which an electric current is passed. The current may either be passed directly through the fluidized bed or may be induced in it in the form of eddy currents. Because of the agitation of the particles in the bed, there is continuous effective distribution of heat throughout the fluidized bed. The current may pass into and out of the bed through electrodes immersed in the bed. An alternative arrangement is for the base of the chamber containing the fluidized bed to form one electrode, other electrodes being arranged to extend into the bed through the wall of the chamber. The particles forming the bed will be chosen depending on the operating temperature: metal and alloy powders for the lower and intermediate temperatures, and carbide powders and carbon powder for the highest temperatures. While this fluidized bed resistance heating element will be of particular interest to chemical engineers as a means of heating gases and carrying out reactions in the gas phase, applications in connection with the heat-treatment of metals might be found to present various advantages. The use of such an arrangement in carburizing and nitriding treatments can be visualized. A more unexpected application, which has been mentioned as an example, is the melting of copper swarf. In this application the fluidized bed is formed from coke particles (particle size about 2 mm.) and is heated by current introduced through graphite electrodes immersed in the bed. The copper swarf is sprinkled on to the surface of the bed. The swarf melts, and the molten copper collects at the bottom of the chamber and is tapped through an outlet in the wall of the chamber.

Desirable Intermediate

IN all hot dip coating processes, a good deal of attention is always, quite rightly, devoted to phenomena occurring at the interface. For satisfactory adhesion of the coating, wetting of the basis metal is obviously essential, and some degree of interaction by way of formation of mutual solutions or intermetallic phases may be desirable. It is well known that, on the other hand, such interaction must not be allowed to proceed too far, resulting as it otherwise does in rapid contamination of the bath of molten coating metal and the formation of brittle intermetallic compounds between the basis metal and the coating which are detrimental to the adhesion of the latter. In view of this conventional state of affairs, a fair measure of inventive merit must be ascribed to a process in which appreciable interaction between the melt and the basis metal is actually desired, and the coating formed on the basis metal in the usual way is, in fact, subsequently removed to expose and leave the intermetallic layer. Such a process has been adopted to produce a siliconized surface layer on such metals as molybdenum, tungsten, tantalum and niobium in order to protect them against oxidation when they are heated in air. To produce the siliconized layer, the metal to be treated is immersed in a bath of copper-silicon alloy containing preferably 10-15 per cent silicon and heated to a temperature of between 800° and 1,200°C. The melting point of the bath can be reduced by the addition of one or more metals such as silver, tin, lead, aluminium, etc. Silicon from the bath diffuses into the molybdenum or other metal being treated to form a silicon-rich surface layer, whereas the copper does not react, or reacts only to a small extent, with the metal being siliconized. After the treatment, the layer of copper-silicon alloy is removed from the treated surface by chemical or electrochemical pickling. The molten bath may also contain a proportion of boron which will be incorporated into the siliconized layer and will improve its protective properties.

Skimmer

EXTENSIONS AT HILLS PRECISION DIECASTINGS LIMITED

Machined and Finished Die-Castings

POLISHED and chrome plated refrigerator door handles, gas lighter pistol components, parts for paint spray guns and oil cans, motor car door handles, badges, head-lamp bezels and other motor trim, all manufactured side by side with coffin handles and other funeral fittings, are but a few of the many types of pressure die-castings manufactured by Hills Precision Diecastings Ltd. at their Hall Green, Birmingham, works. This company, established in 1944 by Charles Hill and Co. Ltd., has recently added considerably to its production facilities. These new extensions have been planned with the object not only of providing additional production space and new warehousing facilities, but also to enable re-siting of various departments in a more convenient and efficient manner.

Designing and drawing offices, production planning and control departments, methods and work study departments have all been raised to first floor level in order to release a further 3,500 ft^2 of additional production space on the works floor below. In addition, work services and other offices have been removed from the central area of the plant and new accommodation built for them on the outer perimeter of the building. These include offices for shop floor managers, personnel officer, and also a well equipped laboratory and surgery.

Careful attention has been paid to ensuring comfortable working conditions by the provision of remote-controlled louvred ventilators to allow rising heat to clear quickly. Additional air can be introduced into the workshops through powered units which are provided with heater batteries connected to the steam mains, so that the incoming air can be adequately warmed in cold weather.

At Hills Precision Diecastings the value has been appreciated of supplying die-castings fully finished by machining operations where necessary, by polishing, plating, painting, vacuum coating, and even sub-assemblies made up from several die-cast components. Particular attention is also given to technical development in each of these finishing departments.

Finally, rigorous inspection throughout the plant has been established to ensure that a high standard of quality can be maintained.

Die-Casting Shop

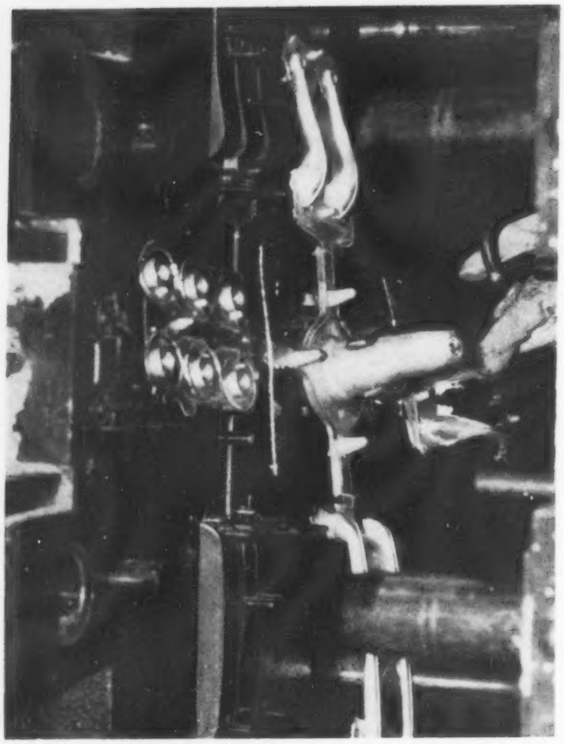
The die-casting area of the factory, comprising approximately 8,500 ft^2, is grouped together at one side and contains three Madison Kipp casting machines, two E.M.B. machines and seven Schultz machines, all casting zinc alloy. A section of this area is devoted to the manufacture of aluminium alloy castings, which are produced on three Herbert Reed-Prentice machines. The new extensions have provided space for the inclusion of a further aluminium machine. Lead casting is carried out at a separate factory some two or three miles away in order to avoid the danger of contamination of Mazak with lead.

The alloys in current production are Mazak III and aluminium alloys LM2, LM6 and LM24.

Interesting features of the die-casting machines are the extensive use which is being made of four-unit and two-unit die blocks, in which each unit may carry any of a number of different individual die impressions. Use of this system enables the time lost on tool changes to be reduced very considerably, and also helps materially in improving the economics of relatively short run requirements. A further feature of the casting shop, designed to improve the overall economics of production, is the extensive use of the cast/clip arrangement. Clipping presses have been situated so conveniently near to the casting machine that it is practicable for the operator to place the spray of castings from a casting machine directly into the press during the normal cycling time.

Thus, the operations carried out at the die-casting machine and clipping press are co-ordinated as follows. Having initiated the die-casting machine cycle, the operator takes a spray of castings from the draining tray in the quench tank and places it in the clipping press. He then initiates the press cycle, which also trips the mechanism for feeding runners and sprues back to the furnace. This trip mechanism is timed to feed into the pot only after the plunger has returned. The caster then turns to the die-casting machine and is ready to remove a new spray of castings from the die. This he places on a quenching tray, which

Layout for production of complex motor trim component. At the rear are the casting machines, with clipping press alongside and band grinding and inspection in front with drilling and tapping of five holes on multi-head special purpose machine in foreground



Schultz die-casting machine fitted with unit die showing production of four different sets of components at one shot

dips to immerse the castings for a controlled time in the quench tank. The cycle is then ready to begin again.

In the clipping press, the trimmed castings fall through on to a moving band conveyor to a line of band grinders (or other equipment as required), where the slight remaining flash is cleaned up and the component dressed. The sprue and runners from the clipping press are transferred by the caster to a scrap conveyor, supplied by A. L. Marshall (Carlton) Ltd., which carries it to a hopper interconnected with the cycle as outlined above.

Both die cooling water and quench water are carried through a re-circulating system via a roof-mounted cooler which maintains the water throughout the system within a few degrees of room temperature. Controlled quench time and temperature enable shrinkage of castings to be accurately determined—a factor that greatly assists clipping to close tolerances in unit-die clipping tools.

Tooling of the clipping press can also be made up on a unit principle corresponding to that of the die-casting machine. This, again, enables considerable savings to be made on the time lost during tool changes. Furthermore, adjustment of the clipping tools at the initiation of a run enables close clipping to be achieved, thus reducing dressing to a minimum.

All the die-casting machines are operated on single shot automatic or semi-automatic cycling, and the progress of their operation is recorded electrically on a Centralograph recorder, making possible a detailed examination of their operation and an analysis of any down time.

A further effort towards complete machine control is made by the installation in the injection nozzle of thermocouples which indicate nozzle temperature on an Ether temperature indicator. This enables the operator to see at once if nozzle temperature is satisfactory for operation and, apart from avoiding frozen nozzles, has done much to increase nozzle life by avoiding overheating.

It is envisaged that, as production increases and becomes more varied, individual trimming and second operation tools will be moved into position as required alongside the moving band conveyors, thus providing flowline operation. One special - purpose machine, for drilling and tapping five holes in a "boomerang"-shaped casting, has already been installed.

Polishing shop—note elevated position of rectifiers in the background leaving clear floor space beneath

Work Bank

Clipped castings from the die-casting area are fed into a work bank, where they are stored in pallets adjacent to the casting shop area. It is found more convenient and economic to manufacture castings in reasonable production quantities from the die-casting machines, and store them in this bank, from which they can be subsequently drawn for finishing operations to meet customers' scheduled requirements. This work bank contains a range of castings in the clipped, self-colour condition, which are in general production at any one time. Quantities of castings withdrawn from this work bank to produce customers' weekly requirements are fed through into the finishing lines comprising machine shop, polishing shop, plating, painting, assembly, packing and despatch.

Machine Shop

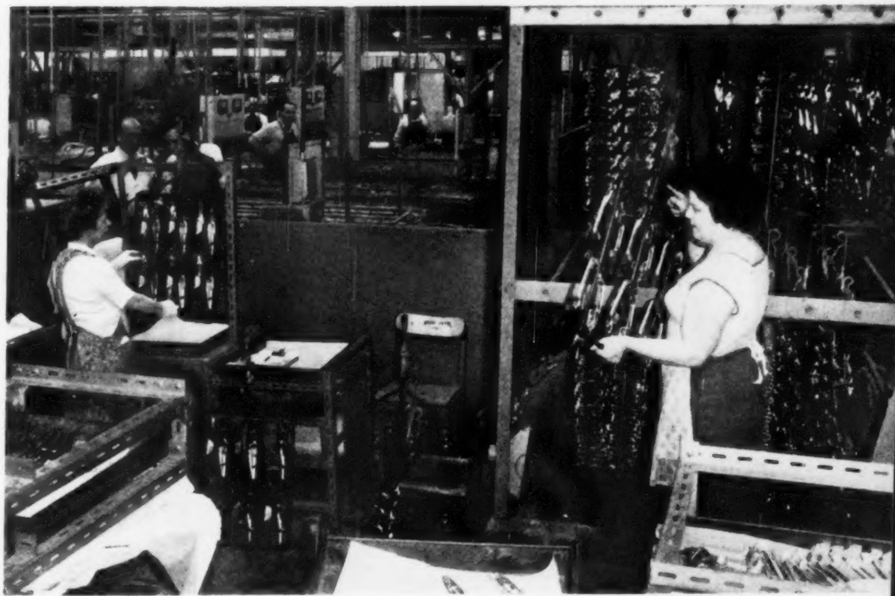
The machine shop equipment ranges from hand presses, bench drillers, etc., to automatic special-purpose machines, the majority of which have been designed by the company to provide fast economic production of large quantities of components. Extensive use is made of plastics nests to hold castings during machining operations

and sliding fixtures for multiple stud running. Two special-purpose machines are of particular interest. One is for drilling four holes in a handle component and broaching a square bore within 6 sec., including loading and unloading; a further and more elaborate special-purpose machine automatically drills and taps five holes in a complex casting in an overall time of 9 sec.

Polishing Shop

Adjoining the machine shop is the polishing shop, containing 26 polishing heads and three backstand idlers. The feature of this shop is the extreme cleanliness achieved by a remarkably efficient dust extraction system. This is essential, as the polishing shop adjoins the plating shop, with no intermediary walling.

On completion of the polishing operations, work which has to move forward for subsequent plating must first be mounted on jigs. The majority of the jigs have been designed and built specially for the individual components currently in production.



Plating shop showing a drying cabinet and its adjoining un-racking bench

Plating Shop

The plating shop facilities provide for plating copper, both bright and Rochelle, bright nickel, chromium, brass, silver and gold. Castings already mounted on jigs from the racking section are fed through the plating lines under careful control of the nearby laboratory, which maintains a constant check on the quality and thickness of the plating. The latter determination is now made on a recently installed B.N.F. Coulometric thickness gauge, which records the thickness of a plated coating within a few minutes and with an accuracy comparable with that achieved by physical measurement of a microsection. Samples are taken every hour for thickness testing, the sample being tested at the point where the deposit is known to be at a minimum. Thus, the specification thickness is maintained at the point of thinnest coating, most of the component having a thicker deposit.

At the end of the plating lines are the drying cupboards, from which the jigs of plated castings are removed, the castings themselves detached and placed in trays ready for final assembly operations, or, if complete in themselves, for packing. The empty jigs are returned to the racking section.

Assembly

The assembly line employs a line of operators, each provided with special equipment together with the various component parts. After assembly, these are then placed on the conveyor belt taking them to the wrappers and packers at the end of the line. Extensive use is made of jigs and fixtures to enable rapid assembly, and of air-driven tools and vibratory feed systems. The assembly operations at any point can be rapidly changed to enable production of a wide variety of different components to be handled simultaneously. It is noteworthy that the new extensions, providing as they do additional work area at this end of the factory, have enabled H.P.D.C. to extend their assembly lines, and provides far more adequate space than hitherto for packing and despatch.

Packing and Despatch

In view of the fluctuations in demand which occur with the majority of the products in regular production, it is normal practice to hold in stock within the warehouse area a minimum of two weeks' requirements of all components. The warehouse itself is housed completely within the new construction.

Paint Shop

As many components are required either fully painted or, as in the case of certain bonnet motifs or handles, painted in part on a chrome plated finish, facilities have been provided within the new extensions for carrying out this operation.

Previously, the paint spray booths had been installed in a separate building, which has been found inconvenient to operate; the new premises now enable all finishing operations to be carried out under one roof. A newly-installed conveyor-type drying oven gives accurate control of drying and stoving temperatures, and within the same area are also housed two machines for vacuum deposition (aluminizing) of metal or plastics components.

Services

Service facilities have been disposed around the perimeter of the production area in order to leave the central area free for production.

The toolroom is well equipped with the latest surface and universal grinding machines, copy milling machines, precision lathes, a shaper equipped with a two-dimensional copying device, heat-treatment facilities, and aquablast equipment. All these assist the toolroom personnel to produce a large proportion of the dies, tools and equipment used for production.

The laboratory is conveniently placed near to the plating section, and is well equipped for qualitative control of all processses. Periodic checks are taken at regular intervals through the day to ensure that a high standard is constantly maintained.

In the new building there is also a packing section dealing primarily with items of coffin furniture for export shipment, and at the end adjacent to the casting shop the general materials stores has been extended. At the furthermost end of the new extensions are also situated the maintenance workshops for cars and vehicles.

A.S.T.M. Standards

SUPPLEMENTS for 1960 to the 1958 Book of A.S.T.M. Standards have now been completed. Each Part-supplement brings up to date the corresponding Part of the 1958 Book of Standards and 1959 Supplement by including new standards and revisions adopted in 1960. As in previous supplements, Part I deals with Ferrous Metals (including, be it noted, titanium alloys), Part 2 with Non-Ferrous Metals, and Part 3 with Methods of Testing Metals. The Supplements are priced at $4·00 per part from American Society for Testing Materials, 1916 Race Street, Philadelphia, 3, Pa.

Products and Processes

TRENDS IN THE DEVELOPMENT, APPLICATION, PROCESSING, DESIGN AND WORKING OF NON-FERROUS METALS AND THEIR PRODUCTS

Electrorefining Zirconium

INVESTIGATIONS conducted to determine the feasibility of molten salt electrorefining of zirconium scrap, off-grade sponge, and alloys, have been carried out by the U.S. Federal Bureau of Mines.

Offgrade zirconium sponge having a Brinell hardness of 169 can be refined by this technique to produce metal having, consistently, a Brinell hardness of less than 90. Also, zirconium alloy scrap, approximating Zircaloy-2 in composition, can be refined to recover zirconium metal with a Brinell hardness of less than 100 that is essentially free of the major alloying elements. Analysis showed that the quantities of these elements were decreased as follows: iron from 0·27 to 0·002, tin from 1·36 to 0·001, nickel from 0·02 to 0·001, and chromium from 0·12 to 0·002 per cent.

An electrolyte was used consisting of molten sodium chloride to which sufficient potassium fluozirconate was added to produce a 2 per cent zirconium content. Zirconium-chloride-bearing electrolytes were unsatisfactory and studies were suspended.

Conditions established for the electrorefining of zirconium and the zirconium alloy studied were: operating temperature $830^\circ \pm 10^\circ$C., cell voltage between 0·2 and 0·5 V, and initial cathode current densities of 200 to 250 amp/ft^2.

Headroom for Lift-Off-Type Annealing Furnaces

THE problem of installing lift-off furnaces in buildings with limited headroom can be overcome in several ways, and at Wire Drawers (Midlands) Ltd., the furnace bases are placed in a well, giving room for the operator to manipulate the covers. Lifting is by a hoist from a beam supported by "A" frames. There is enough clearance to move the furnace, inner covers and the spiders loaded with wire.

The plant, which was supplied by The Incandescent Heat Company Ltd., is being used for stress relieving and annealing of coiled wire and narrow strip. Outputs up to 750 lb/hr. of steel wire at a temperature of 700°C. can be obtained, depending upon loading.

Italian Pressure Die-Casting Machines

A RANGE of hot and cold chamber pressure die-casting machines now being produced in Italy by Rovetta Baldo of Brescia, includes a horizontal cold-chamber type suitable for aluminium, copper, brass and zinc alloys; a cold-chamber type vertical injection machine, and a hot-chamber type with built-in furnace for casting special low melting-point zinc alloys. The range covers locking pressures of 150 to 1,000 tons, and Vickers oil hydraulic operation is used. A double toggle locking mechanism gives positive locking, and access for die changing is good.

Three-speed injection is provided, a slow start, steady continuation and rapid final closing. A short stroke of the piston, synchronized with die opening, forces the casting from the die. The machines can be operated manually or semi-automatically.

Casting weights vary from a maximum of 4½ lb. (2 kg.) of aluminium for the 150-ton machine to 39½ lb. (18 kg.) for the 1,000-ton machine.

Degassing and Brazing at High-Temperature

A COMBINED degassing and brazing furnace for processing nuclear reactor fuel cans has been supplied by Balzers A.G. for the "Dragon Project"—a joint enterprise for testing the feasibility of a gas-cooled high-temperature nuclear reactor.

For the removal of the contaminants and impurities picked up during manufacture, degassing of the parts in high vacuum is necessary. The required degassing temperature of 1,600°C. is higher than the peak temperature which would exist under the working conditions in the reactor.

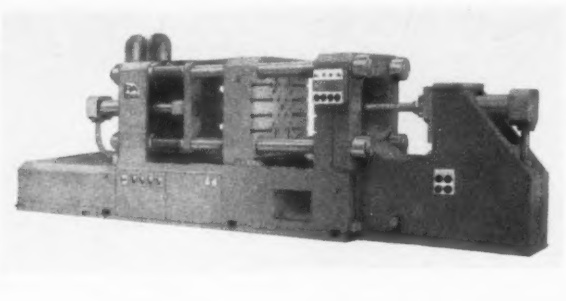
Following this degassing process, the fuel boxes require closing by gas-tight brazing. The filler metal for this purpose—at present zirconium is suggested—requires a brazing temperature of about 2,000°C. In order to prevent re-contamination of the fuel boxes, it is desirable to carry out the degassing and brazing operations in one and the same furnace without breaking the high vacuum.

It has been necessary to modify slightly the fuel boxes. To obtain the required high throughput, 12 fuel boxes are degassed together in the furnace.

After completion of the degassing cycle, the brazing is carried out without breaking the high vacuum. One fuel box at a time is removed from the degassing position and inserted into a high-frequency induction coil where it is brought to the brazing temperature. These movements

Left—Lift-off type annealing furnaces in well to give adequate headroom
[Courtesy Wire Drawers (Midlands) Ltd.

Below—Horizontal cold chamber die-casting machine by Rovetta Baldo



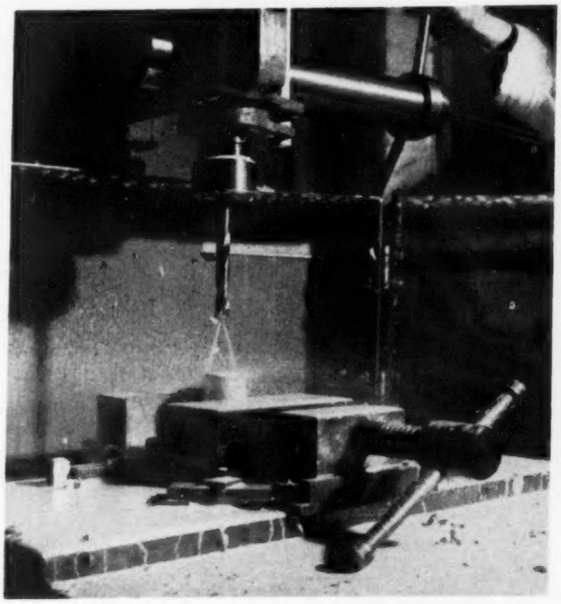
require rather complex mechanisms which are operated from outside the furnace by high-vacuum-tight rotary seals.

Drilling Hard Materials

FOR drilling unusually difficult materials, and for faster drilling of conventional metals, a drill known as the "Cold Point" has been introduced to this country by Coldpoint Drills Ltd., a company within the Simms Group.

The main feature of the drill, which is fully patented, is a fluted shank with a hard metal tip and having a bore running longitudinally through the centre of the drill with outlets at the extreme tip through which a coolant is passed under high pressure. This serves not only to keep the cutting edges cool under all working conditions, but also to wash away the chips of metal which have been cut. The device is being used to drill metals and other materials of any hardness at hitherto unheard of speeds and with very great accuracy. A material has yet to be found which the Cold Point drill will not cut, and its makers claim for it a very high rate of penetration and extreme accuracy.

Among the results of the drilling tests carried out the following may be mentioned: 0·4375 in. dia. holes, 3 in. deep, in Monel, drilled in 150 sec.; in beryllium bronze, 3 sec.; 0·250 in. dia. holes in 18 : 8 stainless steel, 1·5 in. deep, 50 sec.; 0·250 in. dia. hole in glass, 0·5 in. deep, 5 sec. High cutting speeds are essential and, for hard materials, feed rates are best kept low. Water-soluble coolants are used.



Twin jets of high pressure coolant flow continuously throughout the drilling operation with "Cold Point" drills, keeping both the drill tip and the workpiece cool and carrying away chips up the drill flutes, preventing blunting and jamming

Versatile Flexible Furnace

A FLEXIBLE surface heater capable of producing transferred heat at controllable temperatures up to 1,000°C. has been introduced by Electrothermal Engineering Ltd. Temperatures as high as 1,500°C. can be achieved under inert atmosphere conditions.

Ceramic blocks and beads ingeniously interlocked about the element wires form a flexible mat of considerable mechanical strength. Maximum heat transfer coupled with effective electrical insulation is assured.

Standard modular units which can be easily linked together with metal links are available. Custom-built units which can be similarly linked are also available.

The equipment is portable and robust. Suitable for workshop or on site use, it is applicable to heat-treatment processes, vessel heating, stress relieving, preheating for welding, baking-out processes in vacuum, machining and platen heating, environmental testing, portable and permanent furnaces.

Combined Aluminium Car Wheel and Drum

INTEGRAL aluminium wheels and brake drums for cars have been produced and tested in a joint programme between Kaiser Aluminum and Chemical Corpn. and the Bendix Corporation. The wheels were tested on wheel dynamometer, on local road tests cars, and at Death Valley, where 95°F. temperatures prevailed. Sixteen consecutive stops from 70 m.p.h. were made in a brake dynamometer on both the production steel wheel and the aluminium integral wheel, hub and drum. These tests showed that the iron drum used with the conventional steel wheel reached a temperature of 925°F. without showing signs of levelling off, and the stopping time increased from 7 to 25 sec. during these tests.

The maximum temperature of the aluminium integral wheel, hub and drum levelled off at 500°F. about halfway through the test and remained there. The stopping time also remained fairly constant throughout the test, ranging from $7\frac{1}{2}$ to $9\frac{1}{2}$ sec.

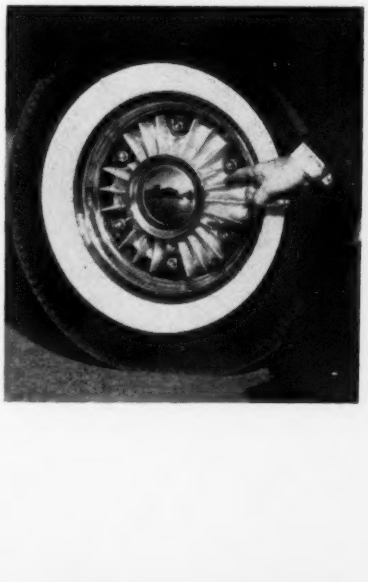
Brake lining life on aluminium wheels was more than double that on the conventional steel wheel.

In addition to its braking advantages, weight savings of up to 30 per cent can be achieved with aluminium in wheels of superior strength. This weight saving lowers unsprung weight when the vehicle is in motion, improving ride characteristics of the car.

The integral aluminium wheel was tested to 500,000 cycles without failure during the fatigue test, although conventional wheels are accepted if they fail at 80,000 to 85,000 cycles.

Left—Flexible furnace applied for high-temperature heating of a pressure vessel

Right—Aluminium wheel fitted to private car



CHROMALLIZING PROTECTS MISSILE-PROBE AGAINST AERODYNAMIC HEATING

Oxidation of Molybdenum

By I. SPRINZ and R. L. WACHTELL

A PROCESS for diffusing a chromium alloy into a molybdenum probe for guided missiles has overcome oxidation and erosion at high temperature at the U.S. Army's Picatinny Arsenal (Dover, N.J.). Formerly, unprotected molybdenum probes began to oxidize when exposed to airstream temperatures of 760°C. and above, a condition that became progressively worse as heat increased.

The alloy, Chromalloy Corporation's W-2 surface alloy, contains a complex of chromium and other metals, and was developed specifically for diffusion into molybdenum.

After chromallizing to a depth of 2 mil, probes have been subjected to temperatures as high as 2,120°C. without failing. Besides protecting the probe against high temperatures induced by air friction, the W-2 surface alloy also reduces the heat transfer rate, thereby holding down equilibrium temperatures throughout the probe.

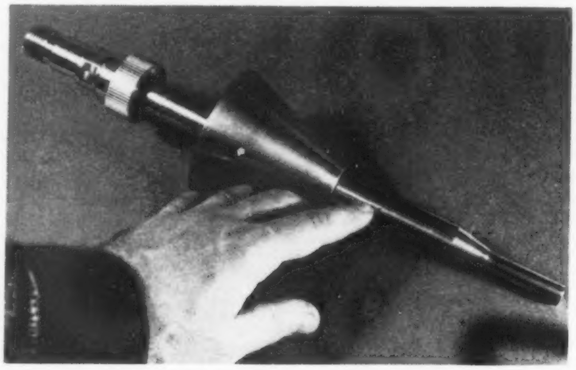
Because the probe must operate under such severe conditions, design was difficult. Probes have a twofold function: (a) to furnish velocity pressure for eleven settings, and (b) to sense static pressure to initiate system fusing.

Heating due to airstream friction is directly related to the probe's profile. In turn, the aerodynamic profile controls the probe's pressure-sensing efficiency. Non-uniform airstream flow might cause erratic flight, or yield inaccurate static pressure measurements.

After a series of wind-tunnel tests, a probe 14·029 in. long with a $\frac{7}{8}$ in. outside diameter was evolved, the main body tapering near the tip to 0·500 in. outside diameter. A hole with an inside diameter of 0·127 in. runs the full length of the probe's centre-line and serves to channel total pressure, subsequently converted into velocity pressure. About 4 in. back from the hollow tip are fifteen tiny holes, spaced evenly around the probe's circumference. These bleed static pressure into a second channel leading to the base of the probe.

Machining of the hard, molybdenum alloy — 0·5 per cent titanium — was accomplished with an electric discharge unit, connected to a counter-rotating feed developed by the Arsenal's engineering staff. This technique was both accurate and relatively fast.

Trepanning the concentric groove that connects the base of the probe to the static-pressure inlet holes proved to be the biggest stumbling-block. This annular groove, 9·8 in. deep and 0·100 in. wide, is separated from the outside wall of the probe by 0·150 in. of metal, and from the centre hole by a 0·124 in. wall. Because of its shape and tolerance, the groove was machined first, by spinning both the discharge tool and the probe itself in opposite directions at a relative speed of about 440 r.p.m. Then the centre hole was spark-machined, concentric with the trepanned hole within 0·001 in.



Static pressure is detected by the chromallized molybdenum probe through fifteen tiny holes on its circumference. They, in turn, are connected to a cylindrical groove inside the probe, running $16\frac{1}{2}$ in. to its base

Molybdenum offers high strength at elevated temperatures, but a means had to be found to protect the metal against oxidation. Among the oxidation barriers tested were ceramic-coated molybdenum, a heat-resistant refractory alloy, molybdenum with aluminium-silicon oxide, ceramic-coated stainless steel, and molybdenum with W-2 chromallizing. Ceramic coatings pulled away from the probe, having a thermal coefficient of expansion approximately three times that of molybdenum. Of the materials evaluated, chromallized specimens successfully met the stringent test and fabrication requirements.

Unusually harsh test conditions were applied, including airstream velocities above Mach 4 at temperatures of 2,120°C. for 45 sec. The diffusion alloy even withstood bombardment from ceramic fragments picked up from the heating bed in the test jet.

The diffusion alloy's resistance to high-temperature oxidation is such that treated molybdenum samples have maintained their strength for extended periods at temperatures as high as 1,260°C.

One company has heated a test-panel with a gas-air torch to 980°C. in 30 sec., held it at that temperature for 15 sec., cooled it to room temperature in 45 sec., and repeated this test 2,000 times without panel failure. A government agency, interested in molybdenum piping, exposed tubing protected by the W-2 surface alloy to 1,370°C. steam for 6 hr. without harm.

In the chromallizing process, probes are packed in a compound containing (1) proper proportions of chromium and other metal powders, (2) inert matter to keep the powders from sintering and to permit gas circulation, and (3) an energizer. Parts are arranged in a retort, then inserted in a furnace. Upon completion of the diffusion cycle, the retort is removed, allowed to cool, and the probes removed.

The retort is sealed against air contamination. During diffusion, the active elements combine with the basis metal, to form a range of new alloys. At the surface, the alloy is rich in the metals introduced, decreasing in alloy content until the original basis metal is reached.

Metallographic examination usually reveals two or three distinct layers, with boundaries at certain fixed percentages of alloying element. Depending on processing conditions, thickness of the surface alloy may be varied considerably. In the case of the missile probes, 2 mils was found to be enough. Because W-2 properties are completely reproducible, thickness can be held within any preset limit. Optimum results, however, are generally obtained from a chromallized thickness of one to three mils.

Obituary

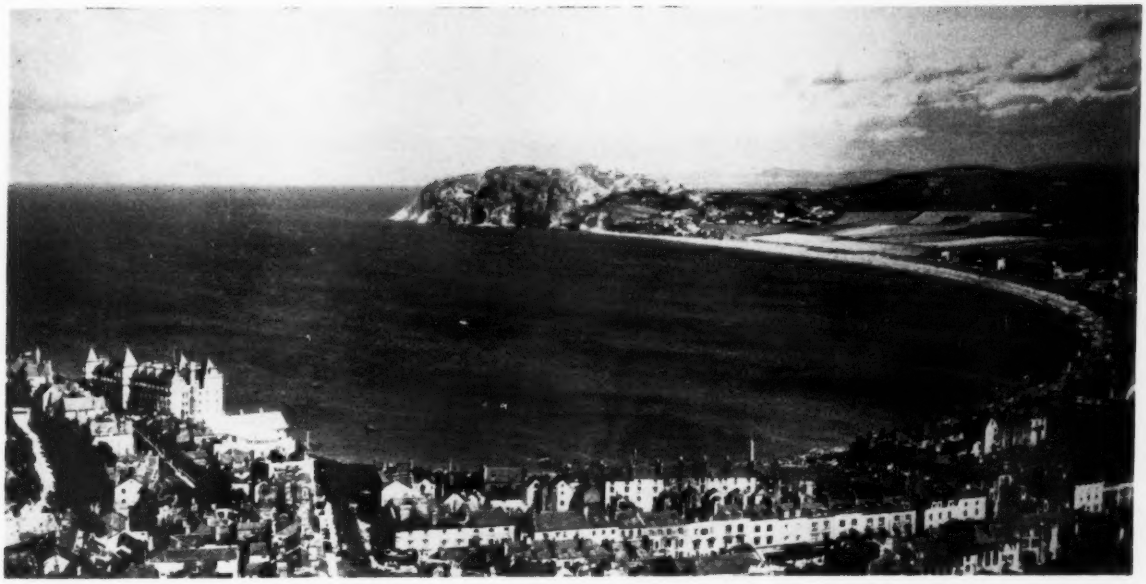
Prof. J. H. Andrew

WE regret to record the death of Professor J. H. Andrew, Professor Emeritus in the University of Sheffield since 1950. He had been Professor of Metallurgy and Dean of the Faculty of Metallurgy from 1932 to 1950.

Prof. Andrew was a founder Fellow of the Institution of Metallurgists and a former vice-president. He had also been a vice-president of the Institute of Metals.

Mr. F. Ehrlich

WE also regret to record the death of Mr. F. Ehrlich, a director of International Refining Co. Ltd. Mr. Ehrlich had served on the board for 26 years and was widely known in the trade.



I.M.F. Annual Conference

EXTRACTS FROM DISCUSSION ON BRIGHTENING AND LEVELLING

LLANDUDNO was chosen as the venue for this year's annual conference of the Institute of Metal Finishing, and a full programme was arranged for the delegates and their ladies. As in previous years, the technical sessions included Papers on a variety of metal finishing topics.

DISCUSSION

The discussion on Mr. A. H. Du Rose's Paper, abstracted on this page, was opened by Dr. J. Edwards.

Dr. J. Edwards (British Non-Ferrous Metals Research Association) said that he was interested in the composition of the nickel deposit in the presence of various organic substances. However, with regard to the author's reference to levelling in the last paragraph of p. 30, he had said, speaking of the Tafel equation, that levelling nickel solutions had high "a" values and low "b" values compared with non-levelling. He had concluded that the difference in levelling power between such solutions should thus become less with increasing current density, and that the throwing power of levelling solutions should not be as good as that of non-levelling. Although these expectations were generally realized, the argument was nevertheless incomplete — since it neglected the rate of change of polarization with concentration, or diffusion rate, of the addition agent, which was of prime importance for levelling. Not all levelling solutions had low "b" values. Dr. Watson had shown that some levelling agents could produce improved throwing power.

He sympathized with Mr. Du Rose's difficulties with regard to the reproducibility of chemical analysis of deposits. He was sure that an imperfect control of plating conditions, solution purity and composition were the more important sources of inconsistency. The difficulties

The Influence of Addition Agents on the Composition of Nickel Deposits

By A. H. Du ROSE

WORK has been carried out over a number of years on the commonly-designated "organic type" bright nickel solutions and the deposits obtained from them. Analyses of carbon, sulphur and nitrogen in the nickel deposit, and cathode polarization in the solution were studied.

It is shown that the sulphur is cleaved from the sulpho-oxygen organic control agent, and in most cases no carbon is contributed by the control agent. A nitrogen-containing organic brightener contributes both carbon and nitrogen to the deposit. There is some reason to believe that the entire brightener molecule (probably in a reduced form) is occluded in the deposit. An attempt has also been made to explain the increase in cleavage of sulphur from the control agent by an increase in cathode polarization caused by the brightener. The rate of increase in sulphur content of the deposit with respect to an increase in control agent concentration is inversely proportional to the control agent concentration. An increase in carbon in the deposit is accompanied by an increase in hydrogen and oxygen. No attempt has been made to explain the kinetics of polarization, nor to distinguish between hydrogen and nickel overvoltage. Polarization, as used here, is that increase in potential as measured by several methods. It is shown, however, that with certain combinations, the above mechanism can take place without any appreciable increase in brightness.

Further work is necessary. Experimentally, the precision of the methods of analysis should be improved so that the source of apparent carbon and sulphur in Watts nickel deposits could be determined. The relation between carbon, oxygen and hydrogen in the deposit should be investigated. The effect of certain control agent molecules which contain brightener constituents, such as amino and aldehyde substituted aromatic sulphonates, should be investigated.

In general, the author's work, and that of others, show that Watts nickel, under conditions as used here, has a (100) preferred orientation. The addition of control agents of the type studied here decrease the crystallite size of the deposit somewhat, and the orientation remains (100). The further addition of a polarizer, however, usually results in a random structure and a greater decrease in crystal size. This holds true whether or not the resulting deposit is bright. However, in some cases, with the combination of control agent and brightening or non-brightening polarizer, some (111) orientation has been observed.

Surface electron microscopic studies show that brightness is associated with absence of surface projections. It would appear that brightening action is similar to that of levelling, the difference being in the size of the surface projections where adsorption takes place.

Trans. Inst. Met. Fin., 1961, **38**, (1), 27.

of maintaining constant conditions were accentuated by the need to produce fairly large samples for chemical analysis. Where radio-tracer techniques could be used instead of chemical analysis, it was often possible to obtain good reproducibility. For absolute values, of course, one was still often dependent on chemical analysis. However, in the case of thiourea, for example, sulphur atoms were strongly adsorbed and their rate of incorporation in the deposit governed by the rate of diffusion of thiourea molecules. It was not too difficult to reproduce values of sulphur content. Carbon content was a different matter. Only a small proportion of the carbon in the thiourea molecules which reached the cathode surface were actually incorporated in the deposit. It was not surprising, then, that the carbon content was rather variable, presumably being very sensitive to small departures from the nominally constant conditions.

The last two columns of Table II showed consistently an increase in carbon and sulphur contents due to the combination of control agent and polarizer, making a strong case for the existence of a synergistic effect. Nevertheless, the variability of some of the results in the Table must raise some doubts about the validity of any of the conclusions drawn. He could, however, offer some supporting evidence, using saccharin labelled with sulphur-33. A deposit from a solution containing rather less than 2 gm/L of saccharin of very low specific activity gave a count of 32 c.p.m. above background. The addition of 5 p.p.m. of fuchsin gave 106 c.p.m.; 10 p.p.m. gave 158 c.p.m.; 10^{-4}M gave 260 c.p.m.; 2×10^{-4}M gave 340 c.p.m., and 5×10^{-4}M produced a streaky deposit not suitable for counting.

The author had suggested that the synergistic effect was due to an increase in polarization produced by the brightener, which caused more effective reduction of the control agent; but in Fig. 1 it was shown that at low concentrations fuchsin reduced polarization, and it was pointed out that this was usually in the presence of a control agent at the concentration of fuchsin used commercially. Furthermore, from his own work it seemed that some polarizers could reduce incorporation of sulphur from control agents, perhaps because they were very strongly adsorbed and could exert a blocking effect.

J. M. Sprague (Consulting Electrochemist) said the range of sulphur and carbon content found in the Watts deposit was so wide he wondered whether it was quite sound to speak in terms of an average figure. What would happen in Table IIIB if one put in the minimum figure of the Watts deposit, drawing up another Table based on the maximum figure?

Dr. T. P. Hoar (University of Cambridge) said his department had been studying the action not only of brightener agents but "control agents"—stress reducing agents—and the results obtained matched many of the author's. They had turned away from addition agents to study the nickel process itself—the deposition of nickel and the dissolution of nickel—and had found it an exceedingly complex process.

First, what was the structure of the ordinary double layer as it was set up on nickel in a pure solution containing no addition agents at all? There was little doubt that sulphate ions had an effect on this, and if both a nickel chloride solution and a nickel phosphate solution were polarized, a different result would be obtained in each case.

The opening ceremony of the Annual Conference of the Institute of Metal Finishing. At the microphone is the chairman of Llandudno U.D.C. Councillor R. Roberts, J.P. Seated are Mr. A. A. B. Harvey (President of the Institute), Dr. S. Wernick and Dr. J. E. Garside

When agents were added, certain things happened, well known but not always recognized: first, adsorption, then either decomposition or reduction, or no effect on whatever was adsorbed, then the adsorbed material either in its original state or through its decomposition products, either decreased or increased the polarization. Finally, it may or may not be incorporated.

It had been suggested that sulphonates were incorporated in the deposit and decorated dislocations in such a way as to turn the latter from outward-pointing to inward-pointing, and changing the stress from tensile to compressive. This probably did happen—that the sulphur ion decorated dislocations in the nickel lattice, rather than replaced nickel ions in the perfect lattice. He preferred this to the author's sulphur solid solution theory.

J. Chadwick (Joseph Lucas Ltd.) referred to the author's concluding paragraph, in which he had said that brightness was associated with absence of surface projections. He asked for clarification, so that it would not be inferred equally that lack of brightness was always due to the presence of surface projections. Everyone was aware that one could obtain a fully bright deposit, with nickel, cadmium, silver and one or two other substances, on a surface which had not been polished at all and was certainly not smooth. Conversely, with a semi-bright levelling nickel one could get a face that was very highly polished. If one put a levelling nickel on top of that, the finish obtained was smoother than the original, but might not be fully bright. He wondered whether the author, in referring to "brightness", was thinking more in terms of specular reflectivity than actual brightness.

AUTHOR'S REPLY

A. H. Du Rose, in reply, said that, having in mind the results obtained, he would adhere to what he had said about the "a" and "b" values. He might well be proven wrong later: it could be that it had something to do with the method of determining polarization. They had used two methods, the commutator and the capillary, and differences had been revealed. One of these could be accounted for by the dissimilar temperature of the solution, but the other could not be accounted for in that way. In general, it had been found that any solution which had good levelling seemed to have a little less macro throwing power. In commercial practice it was very unimportant, and one

Levelling Action During Electrodeposition in Nickel and Acid-Copper Solution

By S. A. WATSON

THIS work is an extension of an investigation of the mechanism of levelling reported in 1957 by Watson and Edwards. To test further the validity of the ideas then presented and to allow them to be extended, a considerable amount of further information was collected and correlated.

The effects, on levelling, of variations in agitation, pH and temperature are shown to be in accord with a hypothesis of levelling action put forward earlier. Measurements of levelling power on microgroove record masters are found to indicate satisfactorily the relative levelling action to be expected on commercially abraded surfaces. Cathode-potential measurements have been made with 60 addition agents in nickel solutions and with 30 in acid-copper solution, and where application of the hypothesis to the potential values promised strong levelling action, actual levelling powers were measured. In all such cases, high values were obtained. A method is described which permits rapid identification of levelling agents, by means of a simple cathode-potential change, $\triangle E_m$. It is shown that a non-levelling agent such as saccharin can modify the behaviour of a levelling agent. Published polarographic results are empirically related to levelling action, and it is demonstrated that certain groupings in the addition-agent molecule favour levelling.

Trans. Inst. Met. Fin., 1960, **37**, (4), 144.

could only determine the difference in nickel throwing power by laboratory techniques. Even then it was rather small.

Reference had been made to the carbon analyses, and to apparent discrepancies in Table III. The Table had not been put together to prove their point. In fact, they could have selected data that would have supported their conclusions much more strongly. The aim was to show that there was quite a discrepancy from either the analytical technique, or the plating technique, standpoint.

Dr. Edwards had mentioned reduced polarizers. He was not quite certain what was meant by this: perhaps they should not then be termed polarizers, and he would question whether they would be brighteners in the sense used in the Paper. The latter, of course, left many questions unanswered.

There were, of course, all kinds of surface projections, from the microscopic to the very large. He could not quite understand Chadwick here. The last paragraph in the Paper referred to the other two explanations customarily offered for deposits becoming bright. The Paper had tried to show that essentially the brightness was due to what one might call "micro-levelling".

DISCUSSION

The discussion on the Paper "Levelling Action During Electrodeposition in Nickel and Acid-Copper Solutions" was opened by Mr. T. E. Such.

T. E. Such (W. Canning and Co. Ltd.) felt the most important point now was why should these particular organic compounds lower the potential? It was not just the capacity of some organics to be adsorbed on a growing nickel surface that resulted in this property. Secondary brighteners, such as saccharin or naphthalene sulphonic acids, were adsorbed at the cathode—or at least part of their molecule was so adsorbed—but they did not greatly affect the cathode potential and only gave very slight levelling. The difference might lie in the capacity of these organic levellers to be readily reduced at the cathode. However, secondary brighteners, like sulphonic acids, suffered desulphonation at the cathode, which led to occlusion of sulphur with little carbon. As this desulphonation involved the addition of electrons, it could be looked upon as a form of reduction, and so perhaps even the ease of its cathodic reduction was not the sole criterion for an organic compound to be a leveller.

Classifications such as those given on page 154 should be used with care. For example, he took it that the alcohols in Class B.1 did not include acetylenic types. Also, he presumed that the non-reducible groups of the unsaturated alcohols referred to in C.1 were their hydroxyl groups, for the triple bonds of acetylenic alcohols were easily hydrogenated at the cathode, which was surely reduction, and, of course, nickel was a recognized catalyst for the hydrogenation of acetylenic and ethylenic bonds, as well as other unsaturated systems.

On p. 151, Table VII gave cathode potential in nickel solutions containing thiourea and saccharin, the purpose being to show what effect saccharin had on the potentials produced by thiourea. Unfortunately, there was no similar Table for thiourea by itself and so no such comparison could be made. The graph in Dr. Watson's first joint Paper gave figures for thiourea alone, but gave somewhat different values for the same concentrations of thiourea. Were the differences significant or not? Why had the author chosen these particular ratios of thiourea and succinonitrile with saccharin?

Turning to p. 149 and Table IV, it would have been more enlightening if Dr. Watson had only changed one variable at a time and kept the thickness of nickel constant. He would like to see the effect of current density alone on the levelling given by these various solutions, and this could not be ascertained from the Table. He could not reconcile the figures of 17 and 66 per cent levelling given by the semi-bright nickel for plating at 20 and 40 amp/ft^2 respectively. Under the conditions stated he felt that, while the 66 per cent levelling was correct, the 17 per cent value was too low. He would have expected a figure of about 40 per cent to be obtained.

A. H. Du Rose (Harshaw Chemical Co.) said the author had taken as a measure of levelling, the difference between the depths of groove before and after plating, divided by the average thickness of the deposit. What was meant by "average thickness", and how was it determined? It was stated that the data showed apparent agreement between levelling of grooves and on abraded surfaces. He had difficulty in finding enough comparisons from which to draw a conclusion. At 20 amp/ft^2, the data for the two chloral hydrate concentrations, and dull nickel, did not follow the same sequence as the groove levelling power. At 40 and 80 amp/ft^2, data for only one chloral hydrate concentration were given. In the discussion, the groove levelling for diethyl thiourea was given as 0·9. In the Watson and Edwards Paper, the only value he could find was about 0·25 for this compound at 0·0015 molar. If 0·25 was used, a poor correlation would seem to have been obtained for group levelling versus abraded surface levelling. Should not the last value in Table IV be "9" instead of "1"?

Dr. T. P. Hoar (University of Cambridge) asked for clarification of the observation on p. 153, which read: "It is possible that a substance might affect cathode potential without being incorporated in the deposit or otherwise consumed at the cathode surface, but such a substance, because it would not be removed from the layer of solution adjacent to the cathode, could not function as a levelling agent, although a theoretical levelling power could be calculated for it. Since, however, there is good agreement between the theoretical and experimental levelling curves in all the cases examined, it seems that consumption of the polarizing agent is always a concomitant of the lowering of cathode potential". He was sure that in many cases one could lower cathode potential during deposition by substances which were not incorporated either as themselves or as their decomposition products. One could certainly alter the potential of mercury electrodes by adsorption without getting incorporation. In common with Such, he found the tabulation of materials somewhat arbitrary. For example, only one or two short chain amines had been used, but if the experiments were done with longer chain amines, such as the octyl-amines, it would be found that an enormous effect on polarization was produced. However, he doubted whether they would be incorporated in the deposits except in the minutest amounts.

At the bottom of p. 154 the author said: "Reducibility at a polarographic mercury electrode thus appears to be an empirical means of distinguishing substances which affect cathode potential in nickel solution from those which do not". He did not think this would be found to be general. Many substances were not

Mr. G. Griffiths, Mrs. D. J. Betteridge, Mrs. Griffiths, and Mr. D. J. Betteridge

Mr. E. L. Masek, Mr. R. N. Harris and Mr. F. R. Cook

Mr. H. Castell, Mr. E. S. Spencer-Timms, and Dr. J. Edwards

Mr. J. Dixon, Mr. R. T. Poeton, Mr. B. R. Wilding, Mr. S. J. Glossop, Mr. J. H. Kimberley and Mr. C. F. Corfe

reduced at mercury cathodes, such as long-chain amines, which would be found to affect greatly the cathode potential. The author continued: "It appears that a fall in cathode potential is produced only by substances which are adsorbed on a freshly deposited nickel surface . . ." With this he would agree, but the author went on " . . . and incorporated in the deposit". There were many cases where that was not true.

Dr. D. N. Layton (Ionic Plating Co. Ltd.) asked how reproducible were the author's measurements of levelling. The author had mentioned one very non-reproducible result—the surface finish obtained by abrasion, especially under normal production methods. This was undoubtedly very common, but high scatter in levelling measurements were also common.

One technique had been found helpful in trying to assess the value of different solutions. If a solution was used in production and advantage was to be taken of its levelling properties, one must have good levelling over a wide range of surface finish. There was no guarantee that in the polishing shop the surface finish would be within a narrow range.

If levelling was plotted against initial roughness, a great deal of scatter occurred in the individual results, but if a slightly different graph was drawn and final roughness was plotted against initial roughness, it was possible without much difficulty to plot a line which fitted the points fairly well and showed a trend. The shape would depend on the particular solution used. By taking various values of initial roughness and reading off figures of final roughness, the levelling at different values of the initial roughness could be calculated. Another graph could then be plotted of levelling versus initial roughness which had varying shapes according to the solution used. It was a very easy and clear way of distinguishing the characteristics of different solutions. Some were of a very marked kind, and what one was seeking was a solution with a wide plateau—high levelling power over a wide range of initial roughness.

Mr. and Mrs. L. Luck, Mr. P. F. Walmsley, Mr. J. W. Oswald, Mr. Osman Jones, Mr. and Mrs. W. K. Bates

AUTHOR'S REPLY

Dr. S. A. Watson, in reply, said that it was true that there was no tabulated data in the Paper for thiourea as there was for thiourea + saccharin. He had had to make a choice from some thirty Tables.

He had been asked why, in the experiments with steel cathodes, the same timings had been used at differing current densities. The aim had been to get some idea of what would happen on a commercial article, where one had a shaped surface.

"Average thickness of deposit" had been obtained by using a flat surface, sectioning, taking a measurement, and converting to what one would get on a piece of microgroove. One could multiply by the ratio of the true to the apparent area. Only one chloral hydrate composition was given because, on the results, the levelling powers were not very different in the two concentrations.

He had re-drawn the earlier graph of Dr. Edwards and himself in the light of further work. Fig. 10 showed a large number of thiourea derivatives. The curves were all very steep. The provisional curves in the earlier Paper had been dotted. It could vary between 0·6 and 1·2 and still give satisfactory results. The last figure in Table IV should indeed be 9 instead of 1.

Dr. Hoar had asked how he could calculate a theoretical levelling power for a substance which gave polarization but was not adsorbed. Provided its effect varied with concentration and current density, one would expect to be able to calculate a theoretical levelling power in the usual way. Their investigations suggested that substances which affected polarization were adsorbed or consumed.

Levelling power was reasonably reproducible because by examining the parameter as a concentration of levelling agent one got a smooth curve, but if one meant levelling action on the pieces of abraded steel, this was not at all reproducible. In the Paper he had made the point that this was an argument for using a standard surface of reproducible form, such as a microgroove. The technique that Dr. Layton suggested seemed valuable, and he would examine it in detail.

Industrial News *Home and Overseas*

A London Event

On Wednesday of last week, the **British Non-Ferrous Metals Research Association** held its annual luncheon at the Savoy Hotel, London, under the chairmanship of **Mr. F. C. Braby,** M.C., D.L., chairman of the council of the Association, who was supported, among other distinguished guests, at the top table, by **Mr. Denzil Freeth,** M.P., Parliamentary Secretary to the Minister for Science; **Sir William McFadzean; Mr. A. E. P. Robinson,** High Commissioner for the Federation of Rhodesia and Nyasaland; **Sir Frank Lee,** G.C.M.G., K.C.B., Joint Permanent Secretary to the Treasury; **Mr. H. Hardman,** C.B., Permanent Secretary, Ministry of Aviation; **Sir John Carroll,** K.B.E., Deputy Controller, Research and Development, Board of Admiralty; **Prof. D. Williams,** President, Institution of Mining and Metallurgy; and **Prof. H. O'Neill,** President, the Institute of Metals.

After the Loyal Toast had been honoured, the toast of "The Association" was proposed by Mr. Denzil Freeth, M.P., and the response was made by Mr. F. C. Braby, who also proposed the toast of "The Guests". This toast was replied to by Sir William McFadzean.

Laboratory Apparatus

At the forthcoming Laboratory Apparatus and Materials Exhibition, to be held in London, some interesting exhibits will be shown by **Hedin Limited.** A new exhibit will be a low temperature environmental test cabinet of compact design, almost silent in operation and with a range of −65°C. to 150°C. It is said to be ideal for testing electronic gear and similar equipment. The manufacturers state that a prototype has been working satisfactorily for two years in the laboratories of one of the leading aircraft instrument manufacturers.

Also on show will be laboratory ovens with forced air circulation which provide close and reliable temperature control up to 300°C., together with uniform temperature distribution. A standard furnace with a temperature range of 1,000°C., suitable for use in the laboratory and toolroom, will also be shown, as well as a wide range of Hedin band, strip and cartridge heaters. A humidity cabinet, Ministry approved, recommended for testing components to RCS 11 and K.114, is included among the exhibits.

New Midlands Depot

Greatly improved services and supplies for plating shops and trade platers are ensured in the Midlands by the opening of the £50,000 depot of the **Electro-Chemical Engineering Company Limited,** at Moor Lane, Witton, Birmingham. This depot is on a two-acre site adjacent to the projected route for the highway linking the Bristol and Preston motorways.

The site has been developed on the most modern lines, allowing speedy expansion of the already considerable sales offices and stores. In addition, an extensive laboratory will soon be providing customers with testing and analytical services similar to those available at the company's headquarters in Sheerwater, Surrey. The new depot will also serve as a base for qualified service engineers and chemists who are available at short notice for Midland customers.

The Witton depot will also serve depots in Manchester and Glasgow, thus completing the coverage of all parts of the country.

Change of Address

It has been announced by **Electronic Switchgear (London) Ltd.** that their address is now Wilbury Way, Hitchin, Herts., with the telephone number of Hitchin 3646.

London Metal Exchange

To mark the opening of the rebuilt London Metal Exchange last month, **Metal Bulletin** has published a separate souvenir 88-page issue which contains a wealth of information on the Exchange and its functions.

Among the articles and features in this special issue are included the History of the Exchange and How it Works; Continental and American Views; The Producers' and Consumers' Viewpoints; and Foreign Exchange Considerations. In addition, there is also a list of member-firms, official warehouses and assayers, and metal brands registered on the Exchange. The price of this publication is 10s. post free.

A Works Visit

During their recent conference in London, the executive committee of the Union Internationale d'Electrothermie toured several large industrial concerns as part of their programme, including a visit to Bromsgrove, Worcestershire, to view the forging works of **Garringtons Limited.** Their particular interest was in the company's application of electricity for induction heating, and it was natural, therefore, that Garrington's rapidly developing Induction Heating Division should form a focal point for their visit.

Their tour comprised the following: press forges, alternator houses and sub-stations, induction heating division, finished products division and heat-treatment department. The visitors were welcomed by Mr. A. J. Taylor, director and manager of engineering and work services, and were entertained by Mr. J. D. Humphries, chief electrical engineer (Induction Heating Division), and Mr. H. Roberts, electrical engineer, and other Garrington personnel.

The party included: Messrs. R. Felix (France), chairman, U.I.E.; P. Naudts (Belgium), vice-president, U.I.E.; R. Gautheret (France), general secretary of U.I.E.; J. T. Sharples, secretary, British National Committee of Electro-Heat; H. I. Hulme, member, British committee; O. Herbatschek (Austria); S. A. Williams, member, British committee; F. Duffield, Midlands Electricity Board; E. Hubbard, Midlands Electricity Board; W. Bolling (W. Germany); G. C. Cova (Italy); H. Norel, Electricity Council; M. Mazur (Poland); H. Masukowitz (W. Germany); O. S. Johansen (Norway); A. Szepessy (Hungary); E. M. Ackery, member, British Committee; K. Selden (Austria); B. Filipovic (Yugoslavia); G. Lehner (Switzerland); K. Zandstra, member, British committee; R. Arsenijevic (Yugoslavia); H. J. Gibson, member, British committee; E. May, member, British committee; and W. de Ruiter (Holland).

Abrasive Sponge

According to the makers, the unusual cellular structure of the new "Artifex" abrasive sponge gives it a degree of flexibility and resilience which enables curved, flat and profiled surfaces to be dealt with in one operation. Because of its resilient structure, close and continuous contact is maintained with the workpiece and only light contact is necessary; little heat is generated and the danger of discoloration or blistering is eliminated. The manufacturers, in fact, state that heavy pressure should be avoided. No coolants, lubricants or compositions are required, which saves time-wasting cleaning and degreasing and gives cleaner working conditions. When health regulations demand wet finishing, the sponge is equally effective.

Because of the structure of the sponge and type of bonding, even grain distribution and non-clogging qualities, it requires only light and infrequent dressing. Wheels can be worn down almost to their clamping plates and then used as small

A group of visitors to the Bromsgrove works of Garringtons Limited, showing in the front row, from left to right: E. May, Member, British Committee; W. de Ruiter (Holland); R. Gautheret (France), General Secretary to U.I.E.; R. Felix (France), Chairman, U.I.E.; P. Naudts (Belgium), Vice-President, U.I.E.; and J. T. Sharples, Secretary, British Committee

diameters on tapered threaded spindles. The sponge is recommended for general surface treatment and produces matt or polished finishes on stainless or other types of steel, iron, brass, copper, bronze, aluminium, plastics and hard woods such as boxwood or teak. It is claimed to polish precious metals with the absolute minimum of stock removal.

This abrasive sponge is marketed by **Finishing Aids and Tools Limited** in four grades: soft, medium hard, hard, extra hard, and in a complete range of grain sizes with wheels up to 16 in. dia. and 4 in. thick. The maximum, safe wheel speeds range from 2,000 - 6,000 surface ft/min., according to grade, which gives the user a variety of r.p.m. to suit existing machinery.

Australian Developments

According to recent news from Sydney, the zinc smelter at the Consolidated Zinc group's A£10 million Cockle Creek plant is due to be started up this month. The process treats lead-bearing materials in conjunction with zinc—a new process to Australia. The company expects an annual metal production of about 40,000 tons of slab zinc. The plant will have a capacity for a similar output of lead bullion. This will lift overall Australian production of lead and zinc metal by these amounts.

The new plant is in addition to existing lead production at Port Pirie and zinc production at Risdon (Tasmania) using Broken Hill and Roseberry (Tas.) ores. The Cockle Creek smelter will use the principle of a blast furnace to produce the zinc metal. Previously, the zinc had to be produced by distillation of electrolytic methods. The Cockle Creek smelter will provide a new outlet for minerals from the Broken Hill line of the lode.

Copper in the Congo

It has been reported by Union Miniere du Haut Katanga that the second stage in bringing the new Luilu copper plant into production has been completed one month ahead of schedule. The capacity of the plant is now 100,000 tons of copper per year. However, a company source pointed out that the increased production at the new plant would not result in an overall increase of the company's copper output, but that ores would be diverted to the new plant from plants which were further away from the mines. Union Miniere also announced that a cobalt plant with an initial capacity of 1,750 tons would be built at Luilu in the near future. The eventual capacity of this plant would be 3,500 tons, the company said.

Nickel Sales Drive

It is reported that the **International Nickel Company** is contemplating a strong sales drive for nickel, and the first step in this plan is a marketing conference for all the organization's agents and distributors both in this country and overseas.

The main purpose of this conference is said to be to foster the use of nickel and to discover new applications. Representatives from some 16 countries will attend the meeting, which is to be held at The Hague.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell by 282 tons to 9,334 tons, comprising London 4,244, Liverpool 3,582 and Hull 1,508 tons.

Copper stocks rose by 410 tons to 16,067 tons, distributed as follows: London 600, Liverpool 12,917, Birmingham 100, Manchester 2,350, Glasgow 50 and Hull 50 tons.

Lead duty-free stocks fell by 85 tons to 8,011 tons and comprised London 7,906, Glasgow five and Swansea 100 tons. In-bond stocks of lead were unchanged at 3,868 tons, all of which were in London.

Zinc duty-free stocks fell by one ton to 4,732 tons, while in-bond stocks rose 355 tons to 1,846 tons. All in-bond stocks were in London. Duty-free stocks comprised London 3,652, Liverpool 900, Glasgow 80 and Manchester 100 tons.

Non-Ferrous Metals in Europe

Activity in non-ferrous metals industries in Europe as a whole should remain in the near future at a level at least as high as that reached by the end of last year, states the Non-Ferrous Metals Committee of O.E.E.C. in its latest brief market survey. There are indications that the upward trend of activity may have lost some of the previous year's impetus, but domestic demand for metals and semi-fabricated products, particularly for engineering industries and building activity, justifies the conclusion that the outlook for the near future is satisfactory.

In all member countries, metal consumption went up—in some cases quite spectacularly—last year and has remained high so far in 1961. Increases in production did not match consumption; imports and hence dependence on raw material supply from outside were, therefore, considerably higher than in previous years. It does not, however, seem likely that 1961 will show another record level. Metal imports from Eastern countries were, on the whole, lower than in previous years. The overall supply situation is expected to remain satisfactory. With regard to the present over-supply of lead in the Western world, the figures show that in O.E.E.C. member countries producer stocks have stayed at a normal level.

Processing industries for aluminium and copper continued to work at full capacity; manpower difficulties and hence long delivery periods for metal products are again reported from a number of countries. The various branches of zinc processing expanded further, although more slowly than in recent years. Demand for lead products made a better show than had been expected in October last year, and demand for nickel remained strong due to the rising production of nickel alloyed steel.

The main features of the situation in the various member countries, production expansion projects and trends in processing industries, are briefly outlined in the Report.

Outlook for Copper

In an address to the annual meeting of the Copper and Brass Research Association, held at Hot Springs, Virginia, on Monday last, Dr. J. Zimmerman, vice-president of Miles Metal Corporation, said that world copper consumers were faced with a paradoxical situation; a rising price trend at a time when production was in excess of consumption. "From a statistical point of view", he said, "the copper market should not be as strong as it is. However, other factors have intervened to offset the present imbalance between supply and demand."

Dr. Zimmerman pointed out that copper was influenced by such things as the unsettled conditions in the Congo and the political and social unrest in South Africa. Also affecting the market outlook, he continued, was the possibility of strikes at Kennecott's United States properties at the end of June and at Anaconda's El Salvador and Potrerillos mines in Chile at the end of July. While there was every indication of a further upturn in the price, Dr. Zimmerman said no runaway market, such as prevailed in 1959 and 1956, was likely. "Mindful of what happened in those years", he said "producers are not likely to run the risk of having their metal priced out of the market and thereby encourage the use of substitutes."

Italian Copper Figures

According to the Central Statistical Institute in Rome, Italian imports of crude copper for refining during January last amounted to 2,964·6 metric tons valued at 1,114,622,000 lire. The main suppliers were Rhodesia and Nyasaland with 355·5 metric tons, South Africa with 917·6 metric tons and the United States with 1,640·6 metric tons.

Imports of refined copper in slabs, ingots, plates, etc., totalled 10,259·3 metric tons last January valued at 3,851,176,000 lire, of which 1,112·1 metric tons, worth 437,401,000 lire, were imported temporarily. The principal suppliers were the Belgian Congo with 2,757·5 metric tons, Rhodesia and Nyasaland with 1,254·5 metric tons, and the United States with 3,032·4 metric tons.

Italy imported 6,063 metric tons of copper scrap during the first three months of this year. This compared with 2,216·2 metric tons in the corresponding period of 1960. Exports amounted to 33·1 metric tons, compared with 7·5 metric tons in the first quarter of last year.

Scrap Merchants Meet

Scarborough was the venue of the annual meeting and conference of the **National Federation of Scrap Iron, Steel and Metal Merchants** this month. The annual report was presented by the retiring President, Mr. G. Rollinson, who is succeeded in that office by Mr. J. E. Ellis, T.D., J.P As announced elsewhere in this issue, Col. W. H. John, Mr. G. Muir, Mr. J. D. Norton, Mr. T. Britton and Mr. J. A. Martin were elected vice-presidents, and Mr. H. B. Brook is President-designate.

Members of the executive council were appointed as follows: Mr. C. Aymer Barrow, Mr. J. Chalmers, Mr. A. Cooper, Mr. R. W. Davies, Mr. G. Davidson, Mr. R. Eastwood, Mr. S. R. Gillott, Mr. T. B. Hopkins, Col. W. H. John, Mr. F. L. Levy, Mr. H. B. McKee, Mr. G. Muir, Mr. O. Mayer, Mr. J. A. Martin, Mr. E. W. Pugh, Mr. R. B. Pocklington, Mr. C. Roberts, Mr. T. Ronald, Mr. F. Smith, Mr. R. Taylor, Mr. J. B. Turner, Mr. J. Wood, Mr. H. D. Wyatt, and Mr. K. L. Young.

Elected to the advisory committee on non-ferrous scrap matters were Mr. A. Allen, Mr. W. L. Nunn and Mr. R Taylor.

At the luncheon which followed the annual meeting, Capt. H. Leighton Davies, C.B.E., J.P., D.L., proposed the toast of the National Federation, and the reply was made by the President, Mr. J. E. Ellis. The toast to the guests was proposed by Mr. T. Ronald, and the response was made by Mr. C. E. de Peyer.

Forthcoming Meeting

Advance notice is given of the annual Electronics, Instruments and Components Exhibition and Convention of the **Institution of Electronics,** which is to be held at

the College of Science and Technology, Manchester, during the periods July 6-8 and 10-12 inclusive.

This exhibition and convention will incorporate a scientific and industrial research section, a manufacturers' section, and a programme of lectures and films on the topics of electronics, instruments and components. Complimentary exhibition admission tickets may be obtained, on forwarding a stamped addressed envelope to Mr. W. Birtwistle, general secretary of the Institution, at 78 Shaw Road, Rochdale, Lancs.

Germanium Scrap Wanted

Important developments in connection with their work on germanium are announced by **Johnson, Matthey and Co. Ltd.** Zone-refined (50Ω-cm-n-type) germanium is now available normally in ingots having a nominal weight of 1 kg. A large scrap-recovery plant has been installed which enables a wide variety of types of germanium-bearing residue to be processed.

It is understood that the company now wishes to purchase large or small quantities of germanium scrap, and will be pleased to hear from any organization having such material for disposal.

Change of Address

As from Tuesday next, May 23, the address of the **Lead Development Association** will be at 34 Berkeley Square, London, W.1, with the telephone number of Grosvenor 8422.

Optical Instruments

It is announced by **Hilger and Watts Ltd.** that Wray (Optical Works) Ltd. have come into association with them. Mr. A. W. Smith is to continue as managing director of the latter company. Mr. Smith is currently chairman of the S.I.M.A. Education Committee and of the City and Guilds Advisory Committee for instrument making.

A Golf Meeting

Arrangements have been made for the **Metal Finishing Association** golf competition to be held this year at Kings Norton Golf Club, Birmingham, on Wednesday, June 21. Full details of the programme may be obtained from the secretary, Mr. P. Burns Farquhar, at 27 Frederick Street, Birmingham, 1.

A Development Programme

Shortly after the appointment, in August 1959, of Mr. A. F. Sabin as managing director of **William Morris and Son (B'ham) Ltd.,** he was joined by Mr. T. Sweeney (works and production manager) and Mr. L. C. Edwards (sales manager). This company has since embarked on a development programme which will ensure that its production of cold rolled strip in copper, brass and phosphor bronze does, in every way, meet the exacting requirements now demanded by manufacturers as a result of the considerable advances which have been made in press tool design and operation, and in metal finishing processes.

A further indication of the intention of this Birmingham company to maintain its position as a progressive member of the industry is the complete rebuilding of the office block, which now provides up-to-date and ample accommodation for the existing personnel, and makes space available for additional staff as the business expands. It is interesting also to note that next year the company will be celebrating its centenary.

Industrial Safety

Requirements for the protection of workers engaged in the **melting or founding of non-ferrous metals** are proposed in the revised preliminary draft of the Non-ferrous Metals (Melting and Founding) Regulations issued on Tuesday last by the Ministry of Labour. These regulations are based on the Report of the Joint Standing Committee on Safety, Health and Welfare Conditions in Non-ferrous Foundries. The first preliminary draft of the regulations (then entitled "The Non-ferrous Foundries Regulations") was published in November 1959, and contained a general invitation to make comments on the proposed regulations.

The text now issued has been prepared in the light of the numerous observations received and of consultations held with organizations of employers, workers and other interested parties. The major change has been the inclusion within the regulations of that part of industry dealing with the melting and casting of metal for the production of non-ferrous ingots, billets, slabs and other similar non-ferrous products, and a consequent amendment of the title to meet the revised scope of the regulations.

Copies of the draft regulations may be obtained from the Ministry of Labour, Safety, Health and Welfare Department (W.5), 19 St. James's Square, S.W.1.

Men and Metals

Following their retirement from the board of the British Rollmakers Corporation, **Mr. O. F. Grazebrook** and **Mr. James Tennent** have been appointed joint honorary Presidents of the Corporation.

It is reported that **Mr. E. W. Rodwell** has resigned from the board of McKechnie Brothers Limited.

In connection with the structural changes in Metals and Alloys (Birmingham) Limited and its associate company, Metallurgical Refiners Ltd., **Mr. P. D. Liddiard,** B.Sc., F.R.I.C., F.I.M. has been appointed managing director of the two companies. Other executive appointments have been announced as follows: **Mr. A. F. Bushell,** M.S.M.A., to be sales manager covering the activities of both companies; **Mr. F. Howitt,** technical manager; **Mr. N. E. Edwards,** sales office manager; **Mr. P. Robinson,** production manager (Powder Products); and **Mr. A. Smith,** production manager (Cast Products).

It has been announced that **Mr. R. S. Gilling,** B.Sc., A.M.I.E.E., has been appointed manager of the Associated Electrical Industries Limited military and marine radar works at Leicester. This is part of the electronic apparatus division.

After playing an important part in building up its membership from 500 in 1945 to over 6,100 in 1961, **Mr. John Blinch** has given up his appointment as director and secretary of the Purchasing Officers' Association. From next month the two appointments will be held separately. **Mr. Peter Emery,** M.A., M.P., has been appointed director, and the secretary will be **Mr. H. Hughes,** A.C.I.S., who has been with the Association since 1948, holding the appointments of assistant secretary and administrative secretary.

Appointed group traffic manager by British Ropes Limited, **Mr. F. M. Fieldhouse** was formerly with the Tarmac group.

New officers of the International Division of Kaiser Aluminum and Chemical Corporation, **Mr. R. A. Clayton,** who has been Vice-President and treasurer of the Corporation, has been elected President of the Division. **Mr. Lloyd Amos,** who has been manager of operations for the Division, has been named as Vice-President, and **Mr. Alanson L. Brooks,** who has been sales manager of the Division since 1958, is also named as a Vice-President.

At the annual meeting and conference of the National Federation of Scrap Iron, Steel and Metal Merchants, held in Scarborough recently, **Mr. J. E. Ellis,** T.D., J.P., took office as President for the ensuing year in succession to **Mr. G. Rollinson. Mr. H. B. Brook** was elected President-Designate. The following gentlemen were elected as Vice-Presidents: **Col. W. Harold John,** O.B.E., **Mr. G. Muir, Mr. J. D. Norton, Mr. T. Britton** and **Mr. J. A. Martin.**

Managing director of Babcock and Wilcox Limited, **Mr. H. McNeill** has been appointed chairman of the Water-Tube Boilermakers' Association in succession to **Mr. J. B. Woodeson,** O.B.E. (chairman, Clarke Chapman and Company Limited), who completed a four-year period as the Association chairman. **Mr. C. J. Howard** (managing director of John Thompson Water-Tube Boilers Limited) has been re-appointed vice-chairman of the Association.

Having relinquished the post of head of the Mechanical Engineering Division of the Kuwait Oil Company, which he has held since 1947, **Mr. E. Jarman,** M.I.Mech.E., F.Inst.Pet., has joined the Council of the British Manufacturers of Petroleum Equipment as technical adviser.

A director of Thos. W. Ward Limited, **Mr. H. H. Mumby** has been elected President of the British Shipbreakers' Association. Mr. Mumby has for a number of years directed the activities of Ward's shipbreaking and non-ferrous metal departments. He is also a director of the Alexander Metal Company Limited.

Metal Market News

LAST week proved to be yet another period of active trading on the Metal Exchange even though consumers seemed to be holding back to some extent. The turnovers in lead and zinc were about average, but in tin and copper the throughput was considerable. Even on Thursday, when, being Ascension Day, all the Continental markets were closed, business in Whittington Avenue was quite good, and probably better than a great many people expected. Evidence seems to be accumulating that the situation in the United States is definitely on the mend, and it may well prove that we shall get over the normally quiet summer months of July and August without too much of a setback in current demand. The international situation, if no better, certainly does not seem to be any worse, and for this we must be thankful. The production of non-ferrous metals in the Continent of Africa has not, so far, suffered any diminution due to disputes and strife, and it is permissible to be reasonably optimistic on this head. Actually, in Northern Rhodesia a measure of curtailment of production continues, and it seems very likely that the Congo is also cutting back output to some extent.

Some further statistics have been made available by the British Bureau in respect of lead and zinc in the month of March, which make reasonably good reading. In lead usage in the U.K. for the month, based on refined and secondary, was 32,601 tons against 30,430 tons in February, while stocks of soft pig lead at March 31 rose by 2,755 tons to 65,683 tons. In zinc, stocks were also up, from 59,958 tons at February 28 to 62,670 tons at the end of March. Consumption, at 31,844 tons compared with 28,118 tons in February, but for the first quarter there was a sizeable decline, of 8,114 tons, compared with the first three months of 1960. The prices of these two metals showed signs of sagging last week, and cash lead closed £1 lower at £66 17s. 6d. on a turnover of 8,625 tons. The forward position lost 17s. 6d. at £68 7s. 6d. Warehouse stocks were 50 tons up at 11,964 tons. Zinc stocks, on the other hand, increased by 737 tons to 5,849 tons, but the quotation lost 27s. 6d. for cash at £82 2s. 6d., while three months closed £1 down at £82 10s. 0d. The turnover was 6,525 tons.

Minor fluctuations were seen in copper on a turnover of 18,750 tons, the close of cash at £242 5s. 0d. showing an increase of 25s., while three months at £243 5s. 0d. was 30s. up. Both positions closed below the best. Stocks rose by 600 tons to 15,657 tons, and during the week the contango widened somewhat. The American market was firm and, undoubtedly, the strength of Comex served to uphold the price in London. Tin fluctuated to a considerable extent, but on balance there were nett gains of £2 in cash at £860, and of £5 in three months at £865. The turnover was 2,315 tons. Stocks declined by 311 tons to 9,616 tons. The price dropped sharply on Thursday, cash to £855 and forward to £859, as a result of a report that the U.S. government had made application to the Buffer Pool for permission to sell 4,000 tons of tin from their trading stocks.

Birmingham

Little change has taken place in the metal trades. Most firms have good order books up to the end of the half year, and prospects are satisfactory having regard to the revival in the engineering industries. The motor trade continues to improve, and short time working has been eliminated. Makers of castings and pressings are busy. Unemployment has dropped, and there are a substantial number of vacancies for semi-skilled and skilled men. Nut and bolt makers are steadily employed on home and export orders. The market for aluminium castings is active.

Trade in iron and steel is maintained. More sheets are needed for the motor body builders now that both home and export business in cars has revived. In the foundries, a wide variety of castings is being produced for the engineering industries, but although consumption of pig iron is larger than it was at the beginning of the year the capacity of the furnaces is more than adequate to take care of the difference. Coupled with this is the considerable demand for basic iron for steelmaking. Re-rollers are well situated for orders for small sections and bars. Pressure for structural steel is maintained.

New York

Futures were firmer in late dealings on new buying, reflecting favourable copper statistics. Domestic copper stocks during April were 25,000 tons lower, and world stocks 30,000 tons lower. Dealings were moderately active. In physical copper, the undertone of custom smelter and producer copper continued firm, but export copper was a shade lower in sympathy with London. Scrap copper was unchanged. Tin was firmer but quiet, following the advance in London, while lead and zinc were moderately active.

The United States is considering whether to sell about 4,000 tons of tin held by the Government outside the national stockpile of strategic materials, the State Department said last Friday. The Department said the U.S. was requested in April by the International Tin Council to consider selling the metal, but no decision had yet been reached. Mr. Joseph Reap, a Department spokesman, made public the Council's request, but told reporters that there was no information on price or other details relating to such a sale.

American officials said the formal announcement followed reports overseas about the suggested release of the tin. They gave no precise reason for the Council's reported request, but they said the price of tin had been rising, and the Council—which represents about two dozen consumer and producer countries on the tin market—might have been concerned about supplies. The U.S., one of the few consumer countries not a member of the Council, was holding the 4,000 tons in a "special inventory" outside the stockpile, officials said. The price of the tin, if it was sold, would be worked out by the U.S. Government, whose general policy was to dispose at the market price. Officials said the general policy was to consult with other governments to get their views before disposing of stockpiled material like tin, to avoid disruption of normal markets.

As we go to press we learn from New York that a leading custom smelter has announced a cut in the price of high grade zinc and special high grade zinc. The price of high grade zinc was reduced by half a cent to 12.35 cents and special high grade also by half a cent to 12.50 cents.

With satisfactory supplies available and no sign of any pick-up in commercial demand, platinum continued its pattern of quiet movement during the week ended May 10. Primary sellers adhered to their officially published asking rates of $82-$85 a troy ounce, depending on quantity. Outside market dealers seemed still in a position to sell at $80 and possibly as low as a dollar below the level.

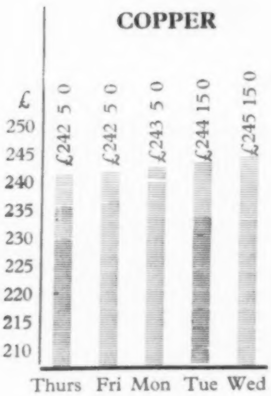
Australia

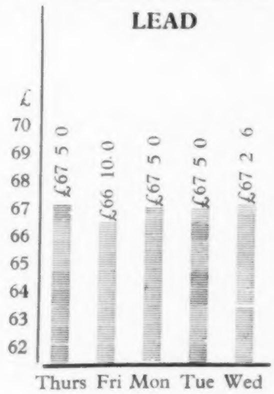
According to latest reports, work will begin next month on a £A40,000,000 project to develop the big bauxite field at Weipa on Cape York Peninsula, North Queensland. The Commonwealth Aluminium Corporation, which holds the rights to develop the field, has let a contract to a Sydney firm to dredge an eight-mile shipping channel 27 feet deep in the river. The channel will later be deepened to 33 feet. The work of dredging the channel will be the first major step in the construction of a port, a township and a plant producing 360,000 tons of aluminium oxide a year. The aluminium oxide from Weipa will be shipped to Lake Manipuri, in New Zealand, for smelting.

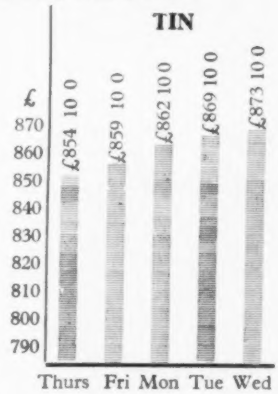
Non-Ferrous Metal Prices

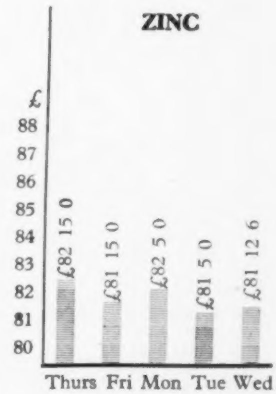
London Metal Exchange

Thursday 11 May to Wednesday 17 May 1961









Primary Metals

All prices quoted are those available at 2 p.m. 17/5/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	,,	237	10	0
Antimony Metal 99%..	,,	230	0	0
Antimony Oxide				
Commercial	,,	194	10	0
Antimony White				
Oxide	,,	212	0	0
Arsenic	,,	400	0	0
Bismuth 99·95%......	lb.		16	0
Cadmium 99·9%	,,		11	0
Calcium	,,	2	0	0
Cerium 99%	,,	15	0	0
Chromium	,,		6	11
Cobalt	,,		12	0
Columbite.... per unit		8	10	0
Copper H.C. Electro..	ton	245	15	0
Fire Refined 99·70%	,,	244	0	0
Fire Refined 99·50%	,,	243	0	0

		£	s.	d.
Copper Sulphate	ton	80	0	0
Germanium	grm.		—	
Gold	oz.	12	11	0¼
Indium	,,		10	0
Iridium	,,	24	0	0
Lanthanum	grm.		15	0
Lead English..........	ton	67	2	6
Magnesium Ingots	lb.			
99·8%	,,		2	2½
99·9+%	,,		2	3
Notched Bar	,,		2	9½
Powder Grade 4......	,,		5	6
Alloy Ingot, AZ91X..			1 11¾-2	1¼
Manganese Metal	ton	280	0	0
Mercury	flask	67	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	,,		5	6
Osmium	oz.	20	0	0
Osmiridium	,,		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	,,	30	5	0
Rhodium	,,	46	0	0
Ruthenium	,,	16	0	0
Selenium	lb.	2	6	6
Silicon 98%	ton	123	0	0
Silver Spot Bars	oz.		6	7⅝
Tellurium Sticks	lb.	2	0	0
Tin	ton	873	10	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	,,		—	
Virgin Min 98%	,,	81	6	10½
Dust 95/97%	,,	125	0	0
Dust 98/99%	,,	131	0	0
Granulated 99+% ..	,,	106	16	10½
Granulated 99·99+%	,,	121	11	3

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg≏£/ton		Canada c/lb≏£/ton		France fr/kg≏£/ton		Italy lire/kg≏£/ton		Switzerland fr/kg≏£/ton		United States c/lb≏£/ton	
Aluminium			26.00	210 12	2.43	179 11	370	216 1	2.50	210 5	26.00	207 4
Antimony 99.0					2.80	206 18	520	303 13			32.50	259 0
Cadmium					16.25	1 200 17					160.00	1,275 4
Copper												
Crude												
Wire bars 99.9							460	269 12				
Electrolytic	33.00	241 3	28.75	232 17	3.32	245 6			2.85	239 13	30.00	239 2
Lead			10.00	81 0	.96	70 18	167	98 10	.80	67 5	11.00	87 13
Magnesium												
Nickel			70.00	567 0	9.00	665 2	1,180	689 2	7.50	630 15	74.00	589 15
Tin	119.75	875 5			12.13	896 8	1,600	944 8	10.30	866 4	109.75	874 14
Zinc												
Prime western			12.25	100 4 0								
High grade 99.95			12.85	104 17 0								
High grade 99.99			13.25	107 6 0					1.05	98 6		
Thermic					1.23	90 17						
Electrolytic					1.31	96 16	189	110 7			13.00	104 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 17/5/61

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10....	„	221	0	0
B.S. 1490 L.M.11....	„	215	0	0
B.S. 1490 L.M.12....	„	223	0	0
B.S. 1490 L.M.13....	„	216	0	0
B.S. 1490 L.M.14....	„	224	0	0
B.S. 1490 L.M.15....	„	210	0	0
B.S. 1490 L.M.16....	„	206	0	0
B.S. 1490 L.M.18....	„	203	0	0
B.S. 1490 L.M.22....	„	210	0	0

Aluminium Alloys (Secondary)				
B.S. 1490 L.M.1	ton	161	0	0
B.S. 1490 L.M.2	„	162	0	0
B.S. 1490 L.M.4	„	171	0	0
B.S. 1490 L.M.6	„	177	0	0

*Aluminium Bronze				
BSS 1400 AB.1......	ton	257	0	0
BSS 1400 AB.2......	„	265	0	0

*Brass		£	s.	d.
BSS 1400-B3 65/35 ..	ton	186	0	0
BSS 249	„	—		
BSS 1400-B6 85/15 ..	„	232	0	0

*Gunmetal				
R.C.H. 3/4% ton	„	—		
(85/5/5/5) LG2	„	232	0	0
(86/7/5/2) LG3	„	242	0	0
(88/10/2/1)	„	305	0	0
(88/10/2/½)	„	294	0	0

*Manganese Bronze				
BSS 1400 HTB1.....	„	202	0	0
BSS 1400 HTB2.....	„	220	0	0
BSS 1400 HTB3.....	„	239	0	0

Nickel Silver				
Casting Quality 12%	„	258	0	0
„ „ 16%	„	270	0	0
„ „ 18%	„	310	0	0

*Phosphor Bronze				
B.S.1400P.B.1.(A.I.D. released)	„	322	0	0
B.S. 1400 L.P.B.1	„	253	0	0

**Average prices for the last week-end.*

Phosphor Copper		£	s.	d.
10%	ton	266	0	0
15%	„	269	0	0

Phosphor Tin				
5%	„	940	0	0

Silicon Bronze				
BSS 1400-SB1	„	295	0	0

Solder, soft, BSS 219				
Grade C Tinmans ...	„	396	0	0
Grade D Plumbers ..	„	315	15	0
Grade M	„	436	5	0

Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.	—		
Type 9 „	„	—		

Zinc Alloys				
BSS 1004 Alloy A ..	ton	115	1	3
BSS 1004 Alloy B....	„	119	1	3
Sodium-Zinc	lb.		2	7

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium			
Sheet 10 S.W.G.	lb.	2	10½
Sheet 18 S.W.G.	„	3	0½
Sheet 24 S.W.G.	„	3	3½
Strip 10 S.W.G.	„	2	10½
Strip 18 S.W.G.	„	2	11½
Strip 24 S.W.G.	„	3	1
Circles 22 S.W.G.	„	3	4½
Circles 18 S.W.G.	„	3	3½
Circles 12 S.W.G.	„	3	2⅛
Plate as rolled	„	2	10
Sections	„	3	4
Wire 10 S.W.G.	„	3	1½
Tubes 1 in o.d. 16 S.W.G.	„	4	4

Aluminium Alloys			
BS1470. HS19W.			
Sheet 10 S.W.G.	„	3	3
Sheet 18 S.W.G.	„	3	5½
Sheet 24 S.W.G.	„	4	1
Strip 10 S.W.G.	„	3	3
Strip 18 S.W.G.	„	3	4½
Strip 24 S.W.G.	„	4	0½
BS1477. HP30M.			
Plate as rolled	„	3	1
BS1470. HC15WP.			
Sheet 10 S.W.G.	„	4	3
Sheet 18 S.W.G.	„	4	8½
Sheet 24 S.W.G.	„	5	8½
Strip 10 S.W.G.	„	4	4
Strip 18 S.W.G.	„	4	8½
Strip 24 S.W.G.	„	5	4½
BS1477. HPC15WP.			
Plate heat treated ...	„	3	10½
BS1475. HG19W.			
Wire 10 S.W.G.	„	4	2
BS1471. HT19WP.			
Tubes 1 in. o.d. 16 S.W.G.	„	5	5
BS1476. HE19WP.			
Sections	„	3	4
Split tube			
19 S.W.G. (½")	„	4	2
20 S.W.G. (⅜")	„	3	11
21 S.W.G. (⅝")	„	4	1
22 S.W.G. (¼")	„	4	11
Welded tube			
14 to 20 S.W.G. (sizes ½" to 1½")	„	3/10½ to 5/8½	

Brass				
Tubes	lb.		1	11⅛
Brazed Tubes	„		3	3⅜
Drawn Strip Sections	„		3	3⅛
Sheet	ton	210	0	0
Strip	„	210	0	0
Extruded Bar	lb.		2	1¼
Condenser Plate (Yellow Metal)............	ton	195	0	0
Condenser Plate (Naval Brass)	„	208	0	0
Wire	lb.		2	9⅜

Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9

Copper				
Tubes	lb.		2	4⅝
Sheet	ton	278	15	0
Strip	„	278	15	0
H.C. Wire	„	294	15	0

Cupro Nickel				
Tubes 70/30	lb.		3	7⅛

Lead				
Pipes (London)	ton	107	0	0
Sheet (London)	„	104	15	0
Tellurium Lead	„	£6 extra		

Nickel Silver			
Sheet and Strip 10%..	lb.	3	11
Wire 10%	„	4	4

Phosphor Bronze			
Wire	„	4	3⅛

Titanium (1,000 lb. lots)			
Billet 4½" to 18" dia.....	lb.	47/-	48/-
Rod ¼" to 4" dia........	„	85/-	53/-
Wire ·036"-232" dia....	„	159/-	99/-
Strip ·001" to ·048"....	„	350/-	68/-
Sheet 8'×2'. 20 gauge	„	73/-	
Tube, representative average gauge	„	198/-	
Extrusions	„	90/-	

Zinc				
Sheet	ton	119	0	0
Strip	„	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 16/5/61.

Aluminium	£
New Cuttings	140
Old Rolled	105
Segregated Turnings	79

Brass	
Cuttings	170
Rod Ends	152
Heavy Yellow	143
Light	138
Rolled	159
Collected Scrap	142
Turnings	145

Copper	
Wire	220
Firebox, cut up	218
Heavy	217
Light	213
Cuttings	225
Turnings	197
Braziery	187

Gunmetal	£
Gear Wheels	210
Admiralty	210
Commercial	194
Turnings	189

Lead	
Scrap	56

Nickel	
Cuttings	—
Anodes	550

Phosphor Bronze	
Scrap	194
Turnings	189

Zinc	
Remelted	76
Cuttings	66
Old Zinc	44

Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of March, 1961 have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follows in long tons:—

COPPER	Gross Weight	Copper Content
Wire	26,739	26,201
Rods, bars and sections	17,361	11,445
Sheet, strip and plate	15,555	12,395
Tubes	8,079	7,480
Castings and miscellaneous	7,828	—
Sulphate	3,409	—
	78,971	64,765

Of which:

Consumption of Virgin Copper	49,409
Consumption of Copper and Alloy Scrap (Copper Content)	75,356

LEAD	
Cables	8,542
Batteries	2,738
Battery Oxides	3,311
Tetra Ethyl Lead	2,320
Other Oxides and Compounds	2,035
White Lead	673
Shot	495
Sheet and Pipe	6,570
Foil and Collapsible Tubes	372
Other Rolled and Extruded	547
Solder	1,461
Alloys	1,839
Miscellaneous Uses	1,698
Total	32,601

TIN	
Tinplate	1,009
Tinning:	
Copper Wire	47
Steel Wire	10
All other	78
Solder	173
Alloys	564
Foil and Collapsible Tubes, etc.	49
Tin Compounds, Salts, and Miscellaneous Uses	162
Total Consumption	2,092

ZINC	
Galvanising	9,314
Brass	10,875
Rolled Zinc	2,479
Zinc Oxide	2,259
Zinc Die-casting alloy	4,927
Zinc Dust	1,037
Miscellaneous Uses	953
Total, All Trades	31,844

Of which:

High purity 99·99 per cent	5,512
Electrolytic and high grade 99·95 per cent	5,459
Prime Western, G.O.B. and de-based	13,551
Remelted	571
Scrap Brass and other Cu alloys	3,996
Scrap Zinc, alloys and residues	2,519

ANTIMONY	
Batteries	121
Other Antimonial Lead	57
Bearings	22
Oxides—for White Pigments	134
Oxides—other	106
Miscellaneous Uses	23
Sulphides	3
Total Consumption	466

Antimony in scrap	
For Antimonial Lead	507
For Other Uses	105
Total Consumption	612

CADMIUM	
Plating Anodes	55·00
Plating Salts	9·65
Alloys: Cadmium Copper	7·80
Alloys: Other	2·25
Batteries: Alkaline	6·15
Batteries: Dry	0·40
Solder	2·80
Colours	14·30
Miscellaneous Uses	1·15
Total Consumption	99·50

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

France (new francs per kilo):

Electrolytic copper scrap	(£221.14.0)	3.00
Heavy copper	(£221.14.0)	3.00
No. 1 copper wire	(£206.18.0)	2.80
Brass rod ends	(£169.19.0)	2.30
Zinc castings	(£71.13.0)	0.97
Lead	(£66.10.0)	0.90
Aluminium	(£125.12.0)	1.70

Italy (lire per kilo):

Aluminium soft sheet clippings (new)	(£178.2.0)	305
Lead, soft, first quality	(£81.15.0)	140
Lead, battery plates	(£46.14.0)	80
Copper, first grade	(£227.15.0)	390
Bronze, commercial gunmetal	(£201.9.0)	345
Brass, heavy	(£163.10.0)	280
Brass, light	(£152.16.0)	260
Brass, bar turnings	(£163.10.0)	280
Old zinc	(£64.4.0)	110

Japan (Yen per metric ton):

Electrolytic copper	(£—)	295,000
Copper wire No. 1	(£—)	272,000
Copper wire No. 2	(£—)	257,000
Heavy copper	(£—)	257,000
Light copper	(£—)	225,000
Brass, new cuttings	(£—)	209,000
Red brass scrap	(£—)	215,000

West Germany (D-marks per 100 kilos):

Used copper wire	(£209.10.0)	230
Heavy copper	(£209.10.0)	230
Light copper	(£182.4.0)	200
Heavy brass	(£136.13.0)	150
Light brass	(£100.4.0)	110
Soft lead scrap	(£52.16.0)	58
Zinc scrap	(£52.16.0)	58
Used aluminium unsorted	(£81.19.0)	90

Financial News

A.P.V. Company Ltd.

Group profits, before tax, are shown at £750,235, compared with £495,893 for the year 1959. New profit is £350,151, as against £243,944 the previous year. The board recommends a dividend of 11¼ per cent, less tax. The chairman's statement says that as regards A.P.V.-Paramount Ltd., this company has completed a successful year, the total production and the resulting year's profit being the best so far accomplished.

Amalgamated Metal Corpn.

Group net profit is shown at £525,799 for the year 1960, and dividend is maintained at 11 per cent, with an unchanged 8 per cent final.

Indian Copper

Dividend 27 per cent, 1960 (same). Profit £1,307,982 (£1,202,259) before depreciation £175,000 (same) and tax £500,477 (£439,949). To development rebate reserve £50,625 (£56,250) and general reserve £200,000 (£125,000). Forward £118,750 (£107,121).

International Nickel

An interim report by the International Nickel Company of Canada and its subsidiaries for the three months ended March 31 last, shows net earnings in terms of U.S. currency of $18,660,000 after all charges, depreciation, depletion, taxes, etc. This was equivalent to 63 cents per common shares. This profit compares with $18,016,000, equal to 62 cents per share, in the three months ended December 31, 1960, and $24,932,000, equal to 85 cents per share in the first quarter of 1960.

Norwegian Aluminium

It is reported from Oslo that the state-owned A/S Ardal and Sunndal Verk turned out 112,000 tons of aluminium last year, a new record, and 18,000 tons more than in 1959, according to the concern's annual report. An expansion scheme was now well under way, which would boost capacity to 150,000 tons by the end of this year, it added. Total sales of aluminium rose from 286,000,000 kr. in 1959 to 321,000,000 kr. last year. New profit was up from 35,000,000 kr. to 46,500,000 kr.

Metal Products Co. (Willenhall)

Final dividend 7½ per cent, making 15 per cent (same) year March 31, 1961. Trading profit, etc., £86,297 (£96,994). Tax £33,004 (£39,000), less over-provision £5,176 (£2,841). Net profit £41,921 (£42,805). To general reserve £15,000 (same), dividends £39,666 (same), forward £50,537 (£48,282).

Newman's Tubes

Net profit, year to January 31, 1961, £85,232 (£90,746) and dividend 25 (20) per cent. Current assets £493,743 (£381,215) and liabilities £245,508 (£181,883). Fixed assets £273,811 (£247,826), commitments £80,000.

Canadian Investment

Aluminium Limited of Canada has been authorized to invest $11,036,895 through Aluminio Argentina SA in the installation of an aluminium rolling plant at Zarate, in the Province of Buenos Aires, where electric cables will also be manufactured, according to the British Chamber of Commerce in the Argentine Republic.

THE STOCK EXCHANGE

Volume Of Business Maintained But Prices Irregular In Places

ISSUED CAPITAL ●	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 15 MAY	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	33/6	+6d.	11	9	6 11 3	33/6	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/3		NIL	4	NIL	1/3	0/9	1/6	0/9
43,133,593	Stk. (£1)	Associated Electrical Industries ...	42/6	—9d.	15	15	7 1 3	54/10½	40/3	67/3	38/3
3,895,963	1	Birfield	78/9	+6/3	10	15‡	2 10 9	78/9	45/-	51/3	29/-
4,795,000	1	Birmid Industries	93/-	+2/9	20	20D	4 6 0	103/-	71/3	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	34/9	+9d.	17½QT	12½	3 7 0	36/10½	24/9	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/6		5	5	6 18 0	14/6	13/9	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/-		6	6	7 1 3	17/6	16/9	20/-	17/1½
500,000	1	Bolton (Thos.) & Sons	57/6		12½	10	4 7 0	57/6	37/6	43/-	36/-
300,000	1	Ditto Pref. 5%	16/6		5	5	6 1 3	16/6	13/9	16/-	14/3
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	17/-		6	6	7 1 3	18/-	16/6	21/1½	17/7½
18,846,647	Stk. (£1)	British Insulated Callender's Cables	59/-	—3/-	13½	13½	4 11 6	62/-	50/4½	61/4½	47/-
20,456,599	5/-	British Oxygen Co. Ltd., Ord. ...	27/6xcap	+3/3	16D	16	1 19 6	28/4½	17/6	35/-	19/10½
1,200,000	Stk. (5/-)	Canning (W.) & Co.	16/7½	—3d.	15⅝	25+*2¼C‡	4 14 0	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/1½	—1½d.	NIL	12½	—	1/7½	1/-	2/3	1/-
555,000	1	Clifford (Chas.) Ltd.	29/-	+6d.	12	10	8 5 6	29/-	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	15/3	15/1½	16/-	15/10½
300,000	2/-	Coley Metals	4/3		15	15	7 1 3	4/3¾	3/6	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	73/-	—2/-	20	15	5 9 6	81/6	64/-	80/9	59/6
5,399,056	1	Davy-Ashmore	177/-	+4/6	30‡	20	1 13 9	177/-	129/6	147/3	99/6
8,000,000	5/-	Delta Metal	27/3	+3d.	20	17½	3 13 6	27/7½	19/9	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	48/3	+1/9	15	15	6 4 6	52/3	45/-	56/9	45/-
1,155,000	1	Evered & Co.	44/6xd		10B	10ϕ	3 0 0	45/-	42/6	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	38/3	+1/9	10	10	5 4 6	39/6	29/6	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	63/3	+3d.	25	20	3 19 0	65/-	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	20/-		13	11½	3 5 0	21/1½	13/9	16/1½	11/1½
2,500,000	5/-	Glynwed Tubes	29/3	+6d.	22½	25¶	3 17 0	30/-	23/7½	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries ...	41/-	+1/-	19L	16	3 7 0	44/9	34/9	41/9	33/-
696,780	10/-	Greenwood & Batley	28/-xcap	+3d.	30‡	30	5 7 3	29/6	23/9Z	33/6	29/1½
792,000	5/-	Harrison (B'ham) Ord.	14/6		*20‡	*17½	3 9 0	14/6	12/-	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	20/3		7	7	6 18 3	20/3	20/-	23/6	22/-
1,612,750	5/-	Heenan Group	16/6		13	15	3 18 9	17/1½	10/6	13/-	9/10½
251,689,407	Stk. (£1)	Imperial Chemical Industries ...	79/6	+9d.	13¾	11¼	3 8 9	81/6	63/1½	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	16/-	+3d.	5	5	6 5 0	16/-	14/10½	18/-	15/4½
29,196,118	**	International Nickel	146½	—3½	$1.60	$1.50	2 0 0	152½	104	105	84¾
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/6		5	5	6 18 0	14/10½	14/-	16/6	14/6
6,000,000	1	Ditto Ord.	64/-		12	12D	3 15 0	64/3	59/6	67/6	44/9
600,000	10/-	Keith, Blackman	21/3		17½	17½E	8 4 9	21/6	18/3	32/6	17/6
320,000	4/-	London Aluminium	14/1½		12	10	3 8 0	14/6	8/6	12/6	7/10½
765,012	1	McKechnie Bros. Ord	65/-	+1/9	17½F	15F	5 7 9	65/-	53/6	71/6	57/3
1,530,024	1	Ditto A Ord	64/3	+1/6	17½F	15F	5 9 0	64/3	53/3	69/3	55/-
1,108,268	5/-	Manganese Bronze & Brass	16/-		20⅝	20⅝	6 10 0	18/6	14/-	18/6	13/4½
50,628	6/-	Ditto (7½% N.C. Pref.)	5/6		7½	7½	8 3 9	6/-	5/4½	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	99/3	+5/3	12M	13B	2 4 0	100/9	63/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	8/6		50	50	11 15 3	8/7½	6/9	10/9	7/1½
160,000	1	Mint (The) Birmingham	43/-		12½	10	5 16 0	43/-	36/-	39/-	33/6
80,000	5	Ditto Pref. 6%	76/3		6	6	7 17 6	77/6	76/-	80/-	75/-
5,187,938	Stk. (£1)	Morgan Crucible A	70/9	+3d.	13	12	3 13 6	71/3	53/4½	63/-	47/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	15/6		5½	5½	7 2 0	17/-	15/3	18/9	15/9
3,850,000	Stk. (£1)	Murex	51/6	+1/-	22½J	15	5 0 0	51/6	39/9	45/-	35/3
585,000	5/-	Ratcliffs (Great Bridge) Ord. ...	15/9	—6d.	10	10R	3 3 6	16/6	15/9	17/-	14/9
195,000	5/-	Ditto 8% Max. Ord.	4/10½		8	—	8 4 0	5/-	4/10½	5/3	5/-
1,064,880	10/-	Sanderson Kayser	40/-	+1/3	35‡	25	4 7 6	40/-	33/9	40/3	27/7½
3,400,500	Stk. (5/-)	Serck	18/6	+1/4½	12½	17½GD	3 6 6	18/6	15/-	25/6	15/3
8,035,372	Stk. (£1)	Stone-Platt Industries	63/6	—3d.	15	15	4 14 6	67/-	55/-	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/6		5½	5½	7 2 0	15/9	15/-	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	81/-	+9d.	14	20	3 9 3	85/6	72/3	140/3	63/10½
41,000,000	Stk. (£1)	Vickers	36/6	—3d.	10	10	5 9 6	37/3	28/-	39/7½	27/1½
750,000	Stk. (£1)	Ditto Pref. 5%	14/6		5	5	6 18 0	15/-	12/7½	17/6	13/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	20/6		*5	*5	7 5 0A	20/7½	19/9	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	82/-	+1/-	13¾	25	3 7 0	82/-	64/6	94/-	63/-
7,109,424	Stk. (£1)	Westinghouse Brake	44/9	+1/-	11	10	4 18 3	44/9	36/4½	60/6	37/6
323,773	2/-	Wolverhampton Die-Casting ...	12/4½	—3d.	35	30	5 13 0	13/4½	9/-	13/10½	8/1½
591,000	5/-	Wolverhampton Metal	28/9	+3d.	32½	27½	5 13 0	30/-	24/6	39/9	23/9
156,930	2/6	Wright, Bindley & Gell	4/7½	+1½d.	15	20‡	8 2 3	4/7½	3/7½	4/6	2/10½
124,140	1	Ditto Cum. Pref. 6%	13/6		6	6	6 17 9	13/7½	13/6	15/-	13/6
150,000	1/-	Zinc Alloy Rust Proof	5/1½	—1½d.	40	30	7 16 3	5/6	4/6	5/4½	4/-

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% capitalized issue. ●The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. D and 50% capitalized issue. C paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares R and 33⅓% capitalized issue in 8% Maximum Ordinary 5/- Stock Units. ϕ and 6¼% from Capital Profits B and 50% capitalized issue. G and 1¾d special distribution. F and special 5% tax free dividend. H As forecast. ¶And 3 for 7 capitalized issue. L and 33⅓% capitalized issue M and 10% capitalized issue. J and 75% capitalized issue. S and 40% capitalized issue. O calculated at 13¾%. Interim on smaller capital P Calculated at 11½%. Q also 1/- special tax free dividend and 50% capitalized issue. T Per £1 unit. Z After capital reorganization

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Principal: H. A. MacColl, B.Sc., F.I.M.

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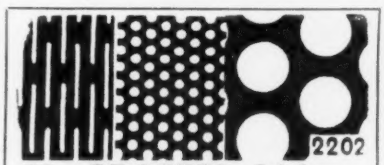
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